MINNESOTA NUMBER Under the Editorial Direction of PROF. C. J. POSEY

The JOURNAL of GEOGRAPHY

A Monthly Magazine Devoted to the Interests of Teachers of Geography in Elementary, Secondary, and Normal Schools.

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Of the Department of Geology and Geography at the University of Wisconsin

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Editor
RAY HUGHES WHITBECK.

Associate Editor
LAWRENCE MARTIN.

Of the Department of Geology and Geography, University of Wisconsin.

Contributing Editors, 1915-16

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The JOURNAL of GEOGRAPHY

Volume XIV FEBRUARY 1916 Number 6

THE PHYSICAL GEOGRAPHY OF MINNESOTA

By A. Walfred Johnston
University of Minnesota

General Geography

LOCATION and area. Minnesota is located approximately at the exact geographical center of North America. It is on the northern boundary of the United States, lying equally distant from Vancouver Island and from Nova Scotia, and half way between the Beaufort Sea and the Caribbean Sea. The part of Minnesota lying north of the 49th parallel in the northwest corner of the Lake of the Woods, which comprises an area of about 150 square miles, is the most northern portion of the United States, excepting Alaska.

The area of Minnesota is 84,682 square miles, including 80,858 square miles of land surface and 3,824 square miles of water surface. This does not include the area of 2,514 square miles of Lake Superior adjoining and within the political boundaries of Minnesota. Its greatest length from the northernmost point in the Lake of the Woods to the Iowa boundary is 408 miles, its greatest width, from St. Vincent to Pigeon Point, is 357 miles.

Geology. The rocks of a large area of Minnesota belong to the oldest formations, the pre-Cambrian, and form the southwest margin of the pre-Cambrian shield of North America. A smaller area, the southeastern part of the state, includes rocks of later formation, the Paleozoic and still younger rocks, the Mesozoic, occur over the western part of the state. These formations, over the greater part of the state, are covered by unconsolidated surface deposits made by the weathering of older rocks, by wind, stream, and wave deposition, and by the continental ice sheet.

The pre-Cambrian areas of Minnesota are made up of igneous and sedimentary rocks and their metamorphosed equivalents. The lavas of Pine and Chisago counties, of the north shore of Lake Superior, and of other areas of northeastern Minnesota; the large masses of intrusive granites, gabbros, etc., in the pre-Cambrian area, are igneous rocks, formed by the cooling of molten material. Some of the slates, the ferruginous cherts, the quartzites of central and northeastern Minnesota, the quartzite of New Ulm, of Watonwan, Cot-

tonwood, Pipestone, and Rock counties are metamorphic rocks, derived from muds, shales, and sandstones. The gneisses and schists of central and northeastern Minnesota and of the Minnesota Valley are also metamorphic rocks. These were made by the alteration of both igneous and sedimentary rocks.

The Paleozoic and Mesozoic areas are made up of sedimentary rocks, limestones, shales, sandstones, and conglomerate.

In general the pre-Cambrian rocks have suffered great changes by folding, faulting, fissuring, and by recrystallization. In some of them the original mineral constituents have been altered and new ones have been developed. The Paleozoic and Mesozoic rocks have been altered very little since their deposition; locally they are folded or gently tilted.

Geological History. The geological events of Minnesota which have a close bearing on its physiography can be summarized as follows: (1) a pre-Cambrian period of deposition of sedimentary rocks and extensive igneous extrusion and intrusion; (2) a period when all the Minnesota area was mountainous, resulting from the folding of the pre-Cambrian rocks; (3) the reduction of the area to a peneplain; (4) the submergence of the greater portion of the area beneath the ocean and deposition of the Paleozoic sediments. These events were not without interruptions and there were oscillations of the sea level during the Paleozoic. (5) A period when the Minnesota area was dry land and denudation was active; during the period the greater portion was reduced to a peneplain; (6) submergence of part of the area beneath the ocean and the deposition of the Cretaceous sediments; (7) a period when Minnesota was dry land, and was being sculptured to something like its present form; (8) a glacial period during which the entire area, except the extreme southeast corner of the state, was buried beneath an ice sheet; (9) a brief post-glacial period.

Topography

Minnesota is a great undulating plain. The larger part of it lies between 1000 and 1500 feet above sea level. The average altitude of the state is about 1200 feet. The greatest altitude, 2230 feet, is found in one of the peaks of the Misquah Hills in north central Cook County. The lowest elevation, 602 feet, is the level of Lake Superior. The level of the Mississippi River where it crosses the state line in the southeast corner is 620 feet, and that of the Red River of the North in the northwest corner is 753 feet. A narrow belt below the 100-foot contour occupies the Red River Valley, and follows down the valley of the Minnesota to its confluence with the Mississippi; here it expands to include a large area to the north and east. It follows the Mississippi River, becoming narrower as the southern boundary is reached. Another area below the 1000-foot contour is a narrow strip bordering Lake Superior. There are three areas above 1500 feet: (1) parts of St. Louis, Cook, and Lake counties, (2) parts of Becker, Hubbard, Clearwater, and Mahnomen counties, (3) the Coteau des Prairies, in the southwestern corner of the state.

HYDOGRAPHY

Drainage. Minnesota is the watershed of the portion of the continent lying east of the Rocky Mountains. Its waters drain into Hudson Bay on the north, into the Great Lakes on the east, and through the Mississippi River into the Gulf of Mexico on the south. The water surface, excluding the part of Lake Superior within the state, is greater than that of any state in the union, the average being 1 square mile of water to 20 square miles of land.

The Hudson Bay-Nelson River system drains the northwestern and northern part of the state and drains about 34 per cent of the area of the state. It is represented by the Red River of the North, the Rainy River, and their tributaries. The Red River of the North rises in the southwestern corner of Clearwater County, about 13 miles west of Lake Itasca, the source of the Mississippi River. The divide between it and the Mississippi River is here about 1750 feet abôve sea level. The divide between the Red River and the Minnesota River is 973 feet. The divide between the Rainy River and Pigeon River on the International Boundary is 1700 feet. The Great Lakes-St. Lawrence River system drains the northeastern part of Minnesota, about 9 per cent of its area. The principal stream of this area is the St. Louis and its tributaries, but there are also many short swift streams flowing directly into Lake Superior. The Mississippi River system is the largest and most important and drains the greater part of the state, or about 57 per cent of its area. Its chief tributaries are the Prairie, Crow Wing, Sauk, Rum, St. Croix, Minnesota, Cannon, Zumbro, and Root rivers. Cedar and Des Moines rivers in southern Minnesota flow through Iowa to the Mississippi. Rock River in the southwestern corner is a tributary of the Missouri River.

Lakes. Excepting the southeast, southwest, and northwest corners, lakes are abundantly distributed over the state. The largest is Red Lake, a shallow body of water with an area of about 440 square miles. Other large lakes are Mille Lacs, Winnibigoshish, Leech, Minnetonka, and Vermilion. In the Lake Park region, beginning near Taylor's Falls, passing southwest to the Twin Cities, and then northwest to Fergus Falls, then north and northeast across the central and northeastern portion of the state, are thousands of lakes of various shapes and sizes. About three-fourths of the lakes of Minnesota occur among the moraine ridges and on outwash areas. Others occur on till plains, in rock basins, in limestone sinks, on flood-plains, and in river channels.

Coast. The northeast projection of Minnesota fronts on the water of Lake Superior, the coast line in the state being about 150 miles. It is a bold, straight shore line rising abruptly from the water's edge several hundred feet. Very few large indentations occur along the entire coast. Small promontories and scattered islands break the monontony near the northern boundary. There are but few good natural harbors. At Two Harbors there is a twofold indentation of the coast by which a double harbor is formed.

The Duluth harbor, at the "Head of the Lakes," is located behind a sand spit, Minnesota Point. It is the best harbor along the Minnesota coast.

Geographical Provinces of Minnesota

The United States may be divided naturally into physiographic provinces on the basis of geographical features, geology, topography, climate, etc. Minnesota lies in two of the larger divisions, the Lake Superior Highlands and the Prairie Plains. These, however, may be sub-divided into smaller physiographic provinces.

The Northeastern Highland. This geographical province occupies the northeastern part of the state and is a broad undulating upland or plateau worn down to low relief. It occupies the site of ancient lofty mountains as is shown by the rocks exposed and the structure of these rocks. Monadnocks—erosional remnants of more resistant rocks—rise above the general level of the plateau. These form striking topographic features, among them the Giants Range, Jasper Peak, and the knobs in the Misquah Hills in Cook County. After this area was peneplained, at least a part of it was lowered beneath the sea and marine sediments of the Paleozoic were laid down on it. It was again uplifted and gently folded and attacked by the processes of denudation, a part of the ancient surface was exposed again; subsequently a part of the region was submerged again and buried beneath Cretaceous sediments. Later it was uplifted and exposed to the processes of weathering which exhumed parts of it. Finally the entire area was modified by glaciation.

Red River Lowlands. The basin of the Red River, occupied by the Glacial Lake Agassiz, in the northwestern part of the state, is a comparatively low area and is one of the most nearly level regions known. It is so flat that much of the rain falling upon it can not find its way into the streams, but sinks into the soil. The surface is covered deeply with fine silt, "lake washed till," and conglomerate; all of these are horizontally bedded. The most striking physiographical features are the former beaches or ridges of sand and gravel, marking the successive levels of Lake Agassiz.

The Lake Superior Lowland. The lowlands of Lake Superior are made up of a narrow strip along the shore of Lake Superior, which extends into eastern Carlton County along the St. Louis River. This area was occupied by the Glacial Lake Duluth. Here also are found beaches formed at successive levels of Lake Duluth. The area is bordered by high escarpments.

The Southern Lowlands. The central and southern portions of Minnesota occupy a low plateau. On the north it slopes gradually to the Minnesota-Mississippi valleys and from the southern boundary it slopes with an even grade northward to the Minnesota Valley. The area is composed of Cretaceous and Paleozoic sediments, with several exposed monadnocks of the pre-Cambrian in the Minnesota Valley and southwestward from New Ulm to Pipestone. The pre-Pleistocene topography is for the most part concealed

by a heavy mantle of glacial drift. In the southwestern portion of this area is a small plateau rising 500 feet above the adjacent upland, the transition from one level to the other, although gradual, is comparatively well defined. This higher plateau extending from Minnesota into the Dakotas, is known as the "Coteau des Prairies." Two other slightly elevated regions in this area mark the topography. One of these is in Mower County, where it forms a flat dome from which the surface slopes gradually in all directions. It rises about 1400 feet above sea level or 200 to 300 feet above the general level of the area. The other elevated region is the morainic area of central Minnesota. Between these three elevated areas there are three troughlike depressions whose axes slope away from the highest elevation in the southwest toward the lowest depressions in the northeast.

MINNESOTA

THE DRIFTLESS AREA OF MINNESOTA, A GEOGRAPHIC UNIT

By Charles C. Colby
George Peabody College for Teachers, Nashville, Tenn.
Formerly of State Normal School, Winona, Minn.

Description of the Driftless Area

An area of approximately 2500 square miles in the southeastern part of Minnesota has conditions of topography, drainage, and soil so different from the rest of the state that it forms a geographic unit. It is a part of the well known unglaciated or driftless area in southwestern Wisconsin, northwestern Illinois, and northeastern Iowa. In Minnesota, the driftless area borders the Mississippi River and is drained by the Root, Whitewater, and Zumbro rivers. It includes all of Houston and Winona counties, and adjacent sections in Fillmore, Olmsted, Wabasha and Goodhue counties.

The driftless area in Minnesota is a region of horizontally bedded shales, sandstones, and limestones dissected to topographic maturity. Here the bed rock, which in most of southern Minnesota is buried beneath a thick deposit of glacial drift, outcrops in the slopes of the valleys. Economically the most important rock is a thick bed of limestone which outcrops in the upper portion of the bluffs along the Mississippi. It is quarried in many places and is one of the materials most used in building basements, bridges, roads, and wing dams in the river.

Topographically this area is divided into an upland and a lowland province. The upland, which is about 1200 feet above sea level, has in its western portion a comparatively level undissected surface, while to the east it is so much dissected by the tributaries of the Mississippi that it exists only as flat topped spurs between the valleys. Such valleys are from 350 to 450 feet below the upland and form a lowland section. In their upper reaches they are narrow, steep sided, and V-shaped. Their lower, wider sections have

more gentle slopes and on their floors there are wide, flat-topped alluvial terraces which rise from 30 to 60 feet above the flood plains of the streams.

Influence Upon Economic Development

The dissected surface of the driftless area has influenced its economic development in many ways. For instance, in this area there is a smaller percentage of land actually in cultivation than in adjacent glaciated sections. This is due primarily to the large amount of land on the slopes of the valleys which is too steep to cultivate. The location of roads and railroads is a second example. On the undissected parts of the upland the roads, except for minor deviations due to small hills or limestone sinks, are built directly between points or on the section lines. In the dissected section they follow the tops of the ridges, converging at the heads of valleys down which they lead to important points in the lowland. Road building is a simple matter on the flat topped terraces but on the flood plains much expensive grading, filling, and bridging is required.

Drainage in this area is active. Because of steep slopes and the absence of lakes and swamps the rivers flood rapidly after heavy rains. On the upland much of the run-off is cared for by sink holes leading to under ground drainage channels. Some of this water collects underground in streams which appear in the valleys as springs of steady flow which supply the drinking water for farm or village. The large number and steady flow of such springs tend to give the streams a uniform volume throughout the year which is of much importance to numerous small grist mills located along their courses.

Because the upper horizons of the bed rock in this area are pervious sandstones and limestones and because of the number and depth of the valleys the permanent water table is far below the surface of the upland. For this reason surface wells on it go dry in periods of drought, which means that the farmers must drive wells from 250 to 400 feet deep in order to have an adequate supply of drinking water.

The flow of water in many of the smaller valleys is intermittent. Their beds and those of the upper reaches of most of the valleys are strewn with bowlders brought down during heavy rains. Where the steep slopes of such valleys are not protected by trees and grass and especially where stock has been allowed to graze over them, the soil has been washed away, leaving gullied areas or acres of bare bed rock. Some of the farmers are checking such erosion by practicing contour plowing, by planting the slopes in grass or shrubs, and by building a series of brush or rock dams to decrease the gradient of the valley.

The drainage on the floor of the valley of the Mississippi contrasts with that of the rest of this area. On it are so many sloughs, cut-offs, ponds, and lakes that the river has a semi-braided character. This means that it is impossible to cross it except at points where roads have been built. Consequently, in the early days when Minnesota depended on the river for a com-

mercial outlet, villages developed at every point where the main channel of the river swings near enough to the side of its valley to furnish a landing place accessible to the back country. The location of Winona, the fourth city in size in Minnesota, is an example. It was located at the point where the main channel of the Mississippi impinges on the lower end of Wabasha Prairie which is a large alluvial terrace. This terrace is situated so that the trade from six valleys and a large part of the upland found its outlet to the river at Winona.

Agricultural Relationships

The driftless area has a variety of soils. Over most of the upland there is a rich, dark colored, fine grained loam derived from the loess which mantles the uplands bordering this section of the Mississippi River. Where the loess is absent the soils are residual, being derived from the underlying sandstone or limestone. Near the border of the drift the soil is modified in some places by thin deposits of sandy outwash gravels. These different soils vary in fertility, which in part explains the variety in crop yields and farm values found within short distances.

The crops grown on the upland are typical for much of southern Minnesota. Barley, oats, and corn are the cereals of largest acreage. They are grown in some plan of rotation with wheat, rye, and forage crops. Stock for market is raised on most farms and much butter is made in local creameries. Such farming, in a climate like that of Minnesota, demands large, well built barns and heavy, expensive machinery.

In the valleys, soils and farm conditions are somewhat different. The soils of the alluvial terraces vary from heavy clay to light sandy loams. Valley farmers grow less cereals than upland farmers. This is due in part to the fact that on most valley farms the areas suited to growing cereals is limited and that the conditions necessary for stock raising are present. In the spring, pasture is furnished on sun-warmed valley slopes and later in the season, during the drought of summer, on the flood plains. In addition springs and streams furnish abundant water for the stock.

Fruits and vegetables also are important products on many valley farms. They grow well on the light alluvial loams of the terraces and in many parts of the valleys they are afforded protection from drifting snows, and excessive freezing and thawing. About the larger valley towns like Winona, Red Wing, Lake City, and Wabasha, there are many small truck farms whose products supply the local demands and in addition are shipped to other sections of the state.

THE CLIMATE OF MINNESOTA

By Eugene Van Cleef
State Normal School, Duluth

MINNESOTA'S continental climate is one of the most diversified among the states in the Great Lakes region. While continental characterizes it in the northeast, the northwest, the central and the southern part, in none of these areas are the variations in the climatic elements just alike. Certain generalizations may be made if the state be divided into a northern and a southern part. Subsequently a few characteristics peculiar to more limited areas will be noted.

Importance of Cyclones and Anti-Cyclones

The state lies in the path of cyclones and anti-cyclones that pass in a general west to east direction. These extensive areas of alternating low and high pressure are the controlling factor. With them comes the clear weather, the rain, the snow, the heat, the cold, the wind, and all the other elements that either please or displease us. The winds to which some people object are a considerable asset. Over most of the state the northwesterlies prevail; while for Duluth and other points along the shore of Lake Superior, the northeasterlies predominate. The average wind velocity for all the state of 16 to 17 miles per hour deserves respect. It means the almost continual movement of the air, and therefor freshness and stimulation that invigorates the citizens.

Temperature

The temperature is another important element affecting the welfare of the people. A knowledge of the range of temperature for each season of the year enables the farmer to select seeds of plants that can best adapt themselves to the region. A simple tabulation of the average temperatures for each of the four seasons follows:

Seasons	*Northern Minn.* F°	*Southern Minn.* F°
(May (June (July	61—66	67—70
(August (September (October	39—44	45—48
(November (December (January	5—13	14—16
(February (March (April	33—40	41—44

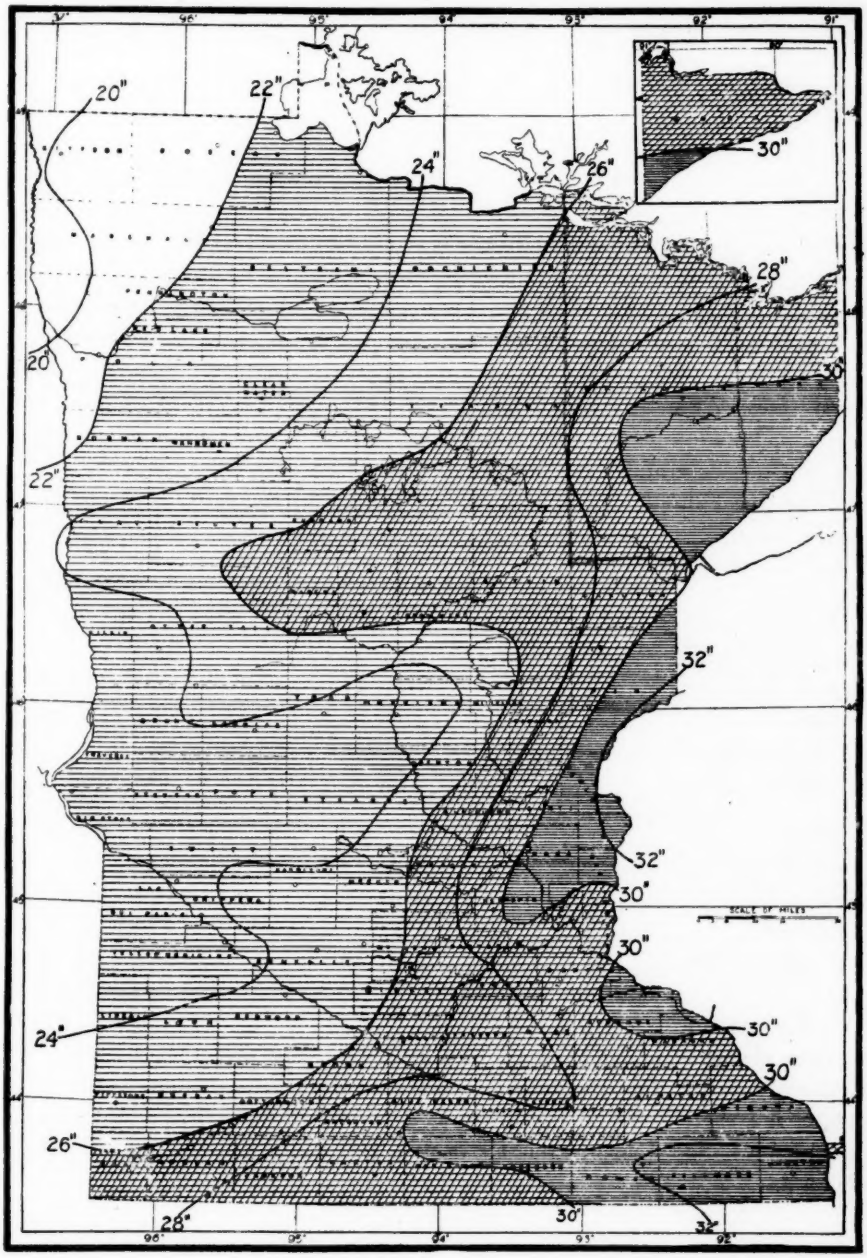

Fig. 1. Map showing average annual precipitation for Minnesota. From Bulletin 12, Minnesota Geological Survey.

The highest temperature ever recorded in the northern part of the state is 104° at Crookston, and the lowest —59° at St. Vincent. 41° below zero has been observed at nearly all points in this section. In the southern part

of the state a maximum of 107° at Grand Meadow stands as the record, while —44° has been known at Pine River Dam. However, such low temperatures are somewhat rare compared with their frequency in the north.

The Growing Season

That the northern part of the state has a markedly lower temperature than the southern districts is easily seen. Perhaps the most striking feature is the decidedly lower minimum from November to April in the north. Right here is one of the reasons for the difference in the length of the growing seasons. In the neighborhood of the Twin Cities and southward the spring season exceeds that in the more northerly part by as much as three weeks. A more detailed tabulation showing the temperatures of every month or even every week of the year would reveal that most significant of all climatic elements so far as crops are concerned, namely, frost. The length of the growing season is determined by the average date of the last killing frost in spring and the first killing frost in fall. A few figures for the parts of the state are worth noting:

	Last Killing Frost Spring	First Killing Frost Fall
North—		
Crookston	May 22	Sept. 15
Fergus Falls	May 11	Sept. 22
Tower	June 5	Sept. 13
Duluth—lake influence controls here	May 3	Oct. 3
South—		
Twin Cities	April 29	Oct. 7
New Ulm	May 6	Sept. 25
Fairmont	May 6	Oct. 3
La Crosse (Wis.)	April 30	Oct. 10

The statement was just offered that frost is the "most significant" of all climatic elements, so far as crops are concerned. Provided that all the other elements balance, this statement is correct. But even though frost were absent and there were no precipitation, certainly without irrigation nothing could grow. So, perhaps, after all there is no single element that is *"most* significant."

Rainfall

The average annual rainfall ranges from 30 inches in the eastern parts to as low as 20 inches in the extreme northwest. Most of the valley of the Red River of the North has between 20 inches and 25 inches of rainfall. The distribution throughout the year, as in the case of other climatic elements is interesting. Over the entire state the rainy season is primarily during the summer months. Everywhere June is the rainiest month. In the northeastern

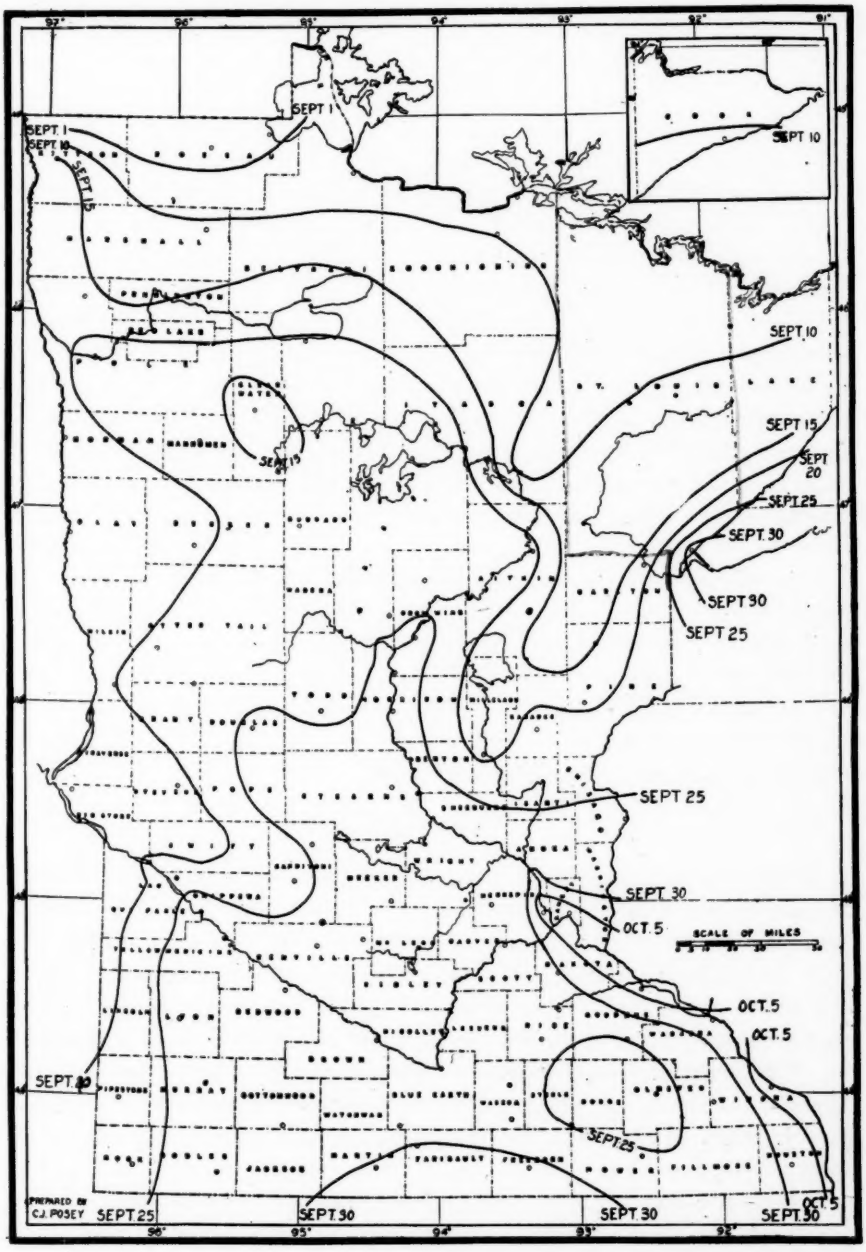

Fig. 2. Map showing average date of first killing frost in autumn in Minnesota. From Bulletin 12, Minnesota Geological Survey.

part of the state a secondary maximum occurs in September. It is to this increase in moisture that the northeastern part of the state owes its seemingly unexcelled grasslands. The rain rarely comes in excessive falls but rather in

normal showers. Thunderstorms are seldom severe and tornadoes have in only one or two instances given the inhabitants any concern.

Snowfall

Minnesota's reputation for fearful blizzards and a tremendous snowfall is not altogether substantiated by the figures. In the north-central and the northeastern parts it amounts to 54″ in depth; in the northwest 35″, in the southwest 30″, and in the southeast 40″ to 50″. When recorded under the general heading of precipitation, that is, as water, these figures are divided by 10. Compare the figure of 36.3″ of snowfall for Chicago, a point usually considered as being free from heavy snow, with St. Paul having 37.1″ or Crookston with 35.8″. Then why the reputation? A return to the temperature figures shows us that practically at no time during the winter season do they rise above the freezing point. Hence the snow accumulates, so that by midwinter and the oncoming of spring several feet of snow have piled up. In Chicago shortly after each snowstorm a thaw occurs. Hence no snow remains on the ground.

In Minnesota the snow, after lying on the ground awhile, freezes. This frozen snow surface makes the building of roads in the forest easy, and so facilitates hauling out of the cut timber. In the farming districts the snow cover serves as a warm blanket for the soils, and in spring the melting snows add moisture to the soils. More directly influencing the individual is the fact that a snow cover prevents the dust from being swept up by the wind and therefor gives a purer atmosphere to breathe.

Humidity

The relative humidity is about normal, ranging from 70% to 80%. With a moderate rate of evaporation and a rather low rainfall in the northwest, the normal relative humidity becomes comparatively high. This means that the water that falls, instead of evaporating rapidly, seeps through the soil and is conserved. Hence plants can get the necessary amount of moisture even in a region of limited precipitation, and crops develop wonderfully.

The percentage of *cloudiness* increases naturally as one approaches Lake Superior. Here it is as high as 55%, while in the extreme western part of the state it falls to 45%. The distribution of sunshine, of course, is the complement of cloudiness.

Hail and fog are infrequent. "Land and sea" breezes occur occasionally along the shore of Lake Superior; but these are not at all pronounced. The observation of the Aurora Borealis offers a frequent source of pleasure and thrill to the residents of the northern part of the state.

Insolation

The high percentage of insolation received during the growing season deserves special mention. Sometimes wonder is expressed that such a short

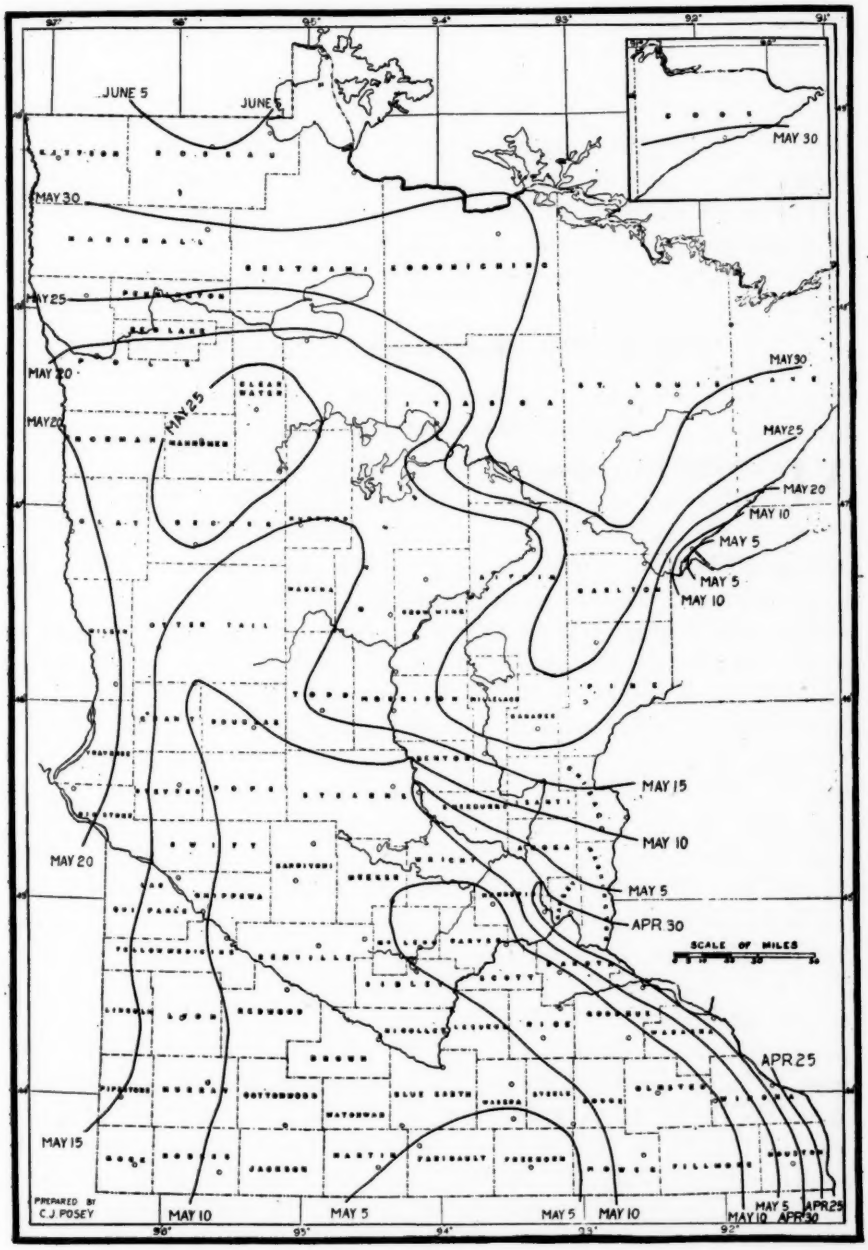

Fig. 3. Map showing average date of last killing frost in spring in Minnesota. From Bulletin 12, Minnesota Geological Survey.

growing season as is here experienced should permit of such vast production. The answer is found in the fact that the days are long; the longest one approximates 16 hours. With a long period of twilight and of dawn in addi-

tion, as much light is available for the plants in two and one-half months as in some places further south where the growing season is four months long, for in the latter localities the length of day is considerably less.

The combination of fertile soils and, sufficient rainfall, normal relative humidity, moderate summer temperatures, low rate of evaporation, constant snow covering in winter, and long hours of sunshine in summer, ranks Minnesota as an agricultural state among the first ten in the country. It also gives to its people an aggressive spirit that is not excelled anywhere.

MINNESOTA

THE WATER RESOURCES OF MINNESOTA

By F. G. Tryon
Rhodes Scholar-elect from Minnesota

MINNESOTA contains the sources of three great drainage systems, the Mississippi, the Nelson, and the St. Lawrence. The basin of each of these three river systems is the seat of valuable water powers within the borders of the state. Of the three, the water powers of the Mississippi and its tributaries are the most numerous and develop the most power.

In a given region the amount of available water power varies with the stream gradient and the amount of run-off. Run-off is the amount of rain falling minus the water returned to the atmosphere through evaporation from open bodies of water, from the soil, and from the leaves of plants.

The highest point in the state is in the hills north of Lake Superior which reach an altitude of 2230 feet, while the lowest point is the level of the lake itself (602 feet). The relief for Minnesota is thus 1628 feet, which is not great considering the area of the state; in comparison with the relief in the Pacific Coast or the New England states, it is insignificant. This relatively low relief tends to limit the available water power in Minnesota.

Minnesota is not a region of exceptionally heavy run-off. While the losses from evaporation are as low as in any area of equal size in the country, yet the moderate rainfall of 27.6 inches, upon which run-off primarily depends, suggests a relatively low run-off. The mean annual run-off varies from 1.1 inches for the Minnesota River watershed above Montevideo to 9.9 inches for the St. Croix River above St. Croix Falls. For the Mississippi watershed above St. Anthony Falls it is 5.3 inches. That is, every year enough water flows over St. Anthony Falls to cover the 19,500 square miles of watershed with a layer of water 5.3 inches deep. By way of comparison it is interesting to note that the run-off of the Ohio River above Wheeling is 22.0 inches.

It is not surprising to find as a result of these factors affecting the run-off that the total amount of available power in Minnesota is much less than in regions of more rugged topography, where slopes are steep and rainfall heavy. As a matter of fact, Minnesota ranks twenty-second among the states of the Union in potential water power. At the head of the list stands Washington,

followed by California, Oregon, Montana, Idaho, Arizona and New York, in order of rank. Louisiana possesses the least potential water power. Minnesota stands about the middle of the list with one-seventeenth as much available power as Washington, and 290 times as much as Louisiana.

While the available power in the state is not great in comparison with the mountainous states, Minnesota streams are in general less subject to fluctuations in flow than those in many other states, and therefore are more satisfactory to the builder of a mill or a hydro-electric plant. The last great glacier which covered Minnesota left in its retreat many lakes, swamps, and undrained depressions which act as natural reservoirs, preventing floods and equalizing the flow of rivers from season to season. The advantages of this greater regularity of flow to the builder of a dam for water power are many. Where heavy floods are rare, a dam need not be as heavy as one for the same sized stream more subject to heavy floods. Moreover, fewer water turbines would be lying idle during the season of low water, for with absence of floods usually goes absence of very low water. While the flow of the Mississippi at St. Anthony Falls is far less uniform than that of Niagara, where the Great Lakes form a perfect natural reservoir, yet it is steadier than most streams in unglaciated country.

In addition to the natural reservoirs formed by the retreating ice sheet the U. S. Corps of Engineers has constructed six reservoirs on the Upper Mississippi capable of holding 98,000,000,000 cubic feet of water. The largest of these is located at the outlet of Lake Winnibigoshish, which with the Leech Lake reservoir holds more than three-fourths of the total capacity. Smaller reservoirs have been constructed at Pokegama Falls, at Gull Lake, at the outlet of Cross Lake on Pine River, and on Sandy River, one mile above its junction with the Mississippi. The reservoirs were constructed primarily to facilitate navigation and to assist in the control of floods, but hydraulic engineers have urged that the stored water be used for water power at the reservoir dams.

In estimating the power available at any site, the question as to whether to design a plant large enough to utilize the flood flow of the stream, or one only large enough to utilize the minimum flow, during the period of low water depends upon the market for power. Where the price per kilowatt is low, the tendency is to utilize only the minimum flow of the stream. In Minnesota, where the cost of generating steam power is considerable because of the high price of coal, and where the market for power is active, it is frequently found practicable to build a plant large enough to utilize the flow of water during the highest six months of the year. The extent of development also depends on the use for which the power is destined. The electro-chemical industries, for example, require an amount of current absolutely constant, year in and year out. A hydro-electric plant supplying power to such an industry may be no larger than can be operated by the extreme low-water stage of the river, unless the deficiency can be supplied by auxiliary steam. On the other hand, a wood-pulp mill can utilize the high-water flow of the stream by

grinding quantities of pulp during high water to be stored until needed at the time of low water.

Keeping these principles in mind, we may understand the estimates of water power available in Minnesota. On the basis of the "minimum flow" during the lowest week of an average year, the potential power is 278,000 horsepower. On the basis of the flow during the highest six months, the power available becomes 494,000 horsepower, a trifle less than one per cent of the potential power in the entire United States. The power actually developed in the state, as indicated by the capacities of the plants now installed, is 188,000 horsepower or about 4½ per cent of the power developed by water in the entire country. Minnesota's water powers are thus more completely developed than those of the country as a whole. From a comparison of the potential and developed power, it may be seen that, on the basis of the minimum flow alone, there remain 90,000 horsepower to be developed in the future. The State Drainage Commission acting in cooperation with the U. S. Geological Survey has published, in the Report of Water Resources Investigation of Minnesota, surveys of unoccupied dam sites of not less than 15 feet head which would develop during the month of lowest flow 120,000 horsepower. As the future development of these sites will doubtless be on a much higher basis than the minimum flow, we may expect the horsepower derived from Minnesota streams ultimately to approach 500,000.

The largest power development in the state is at Minneapolis at the Falls of St. Anthony, where three installations have a combined rating of 57,000 horsepower. Other important developments are Taylor's Falls, 18,750 h. p.; a plant a few miles below Thomson on the St. Louis, 39,000 h. p.; International Falls, 18,000 h. p.; Sartell, Little Falls, and Coon Creek on the Mississippi above Minneapolis, 6,000, 4,100, and 7,500 h. p., respectively; Grand Rapids, 3,600 h. p.; and St. Cloud, 1,750 h. p. Above Fort Snelling on the Mississippi the government high dam now under construction will develop about 15,000 h. p. Other important plants are found at Knife Falls, Cloquet, Brainerd, Cannon Falls, Mankato, and Red Lake. Much of the undeveloped power available is to be found at the sites of these principal installations.

Mention has been made of the economy in using water power in the manufacture of wood pulp. The inhospitable soil of much of northeastern Minnesota, better adapted to forest than to farm, guarantees a constant supply of spruce and hemlock to be ground into wood pulp by power furnished by the numerous streams. The development here of a permanent industry in wood-pulp paper seems assured.

As is well known, it was the Falls of St. Anthony which created Minneapolis. As early as 1821 a rude sawmill was built at the falls to make lumber for the first permanent structure at Fort Snelling. Two years later the first flour mill was erected. It was the combination of cheap power, the northern pineries on the river above, and the grain fields of the Northwest that deter-

mined the location of the city. To this day flour and gristmill products, and lumber and timber products remain the leading manufactures of the state.

Before the days of long-distance electrical transmission, power derived from falling water could be utilized at no greater distance from the water wheel than the length of a belt drive. Modern electrical engineering has made possible the profitable transmission of electrical energy from 100 to 300 miles, the distance depending on the cheapness of competing sources of power. Power sites at a distance from large cities have been tapped to provide electricity for lighting, transportation, and manufacturing. Minneapolis has grown to such proportions as to require more power than the Falls of St. Anthony can furnish; Taylor's Falls on the St. Croix, and Coon Rapids on the Mississippi have been developed to supply the deficiency. The high dam at Fort Snelling is now about to furnish light and power to the same city. In like manner, electric lighting in St. Paul is supplied by current generated at a distance in scattered water-power plants.

As an accompaniment of the multiplication of plants supplying a single market has appeared the tendency to concentrated ownership and operation. The company supplying Minneapolis with light operates three hydro-electric plants at Taylor's Falls, St. Anthony Falls, and Coon Rapids as parts of a single system. This tendency is inevitable and will doubtless proceed further. "The Mississippi River between the mouth of the Crow Wing River and St. Anthony Falls has more undeveloped water power than any other river in Minnesota. The country through which it flows is the most thickly settled portion of the state, affording the best market for power." Unquestionably the future will see these power sites developed by a single agency and managed as part of a single system.

Concentration of ownership, while necessary, has its dangers. To devise means for its adequate regulation is the task of a far-sighted government.

MINNESOTA

THE IRON ORES OF MINNESOTA

By W. H. Emmons
University of Minnesota

MINNESOTA ranks high among the states in the production of metals, a place it owes to its deposits of iron ore. Its output of iron ore exceeds that of all other states combined both in amount and value, being (in 1912) 34,249,813 long tons valued at $61,805,017. Iron is mined in Minnesota on three ranges, the Mesabi, the Vermilion, and the Cuyuna. Of these the Mesabi is the most important iron-mining district in the world. Although shipments began as late as 1892, it had produced at the end of 1913 about 50 per cent of all the iron ore produced in the Lake Superior region up to that time.

The more important mining centers of Minnesota are all located within

100 miles of a Lake Superior port, and all of the iron ores are within 125 miles of Duluth. The ores from the three ranges are carried by rail to Duluth, Two Harbors, or Superior, where they are loaded into lake freighters and shipped to lower lake ports. Essentially all of the ore is smelted with eastern coke. It is about as economical to carry iron ore to coke as to carry coke to iron ore; iron and steel plants are therefore located near the coke fields, near the iron fields, or on the lines of transportation between the two. Thus great industries have been built up at Duluth, Sault Ste. Marie, Milwaukee, Chicago, Gary, Detroit, and at many places in Ohio and Pennsylvania. These supply the iron and steel markets which are most accessible to them. The freight saving in the distribution of the product that is obtained from widely spaced smelting centers over distribution from a single center is obvious.

The prices paid for the ores depend upon their composition and character. Because it is more easily smelted in the furnace, hard ore brings about 25c a ton more than soft ore. Iron made from ore with very low phosphorus content can be used in Bessemer furnaces which produce steel at low cost, and such ore sells for about 65 to 75 cents a ton more than non-Bessemer ore. The prices in 1915 for Mesabi non-Bessemer carrying 51.5 per cent iron in the natural state was $2.80 per ton at lower lake ports, and for Bessemer, carrying 55 per cent, it was $3.40. The prices increase rapidly for ores above the grades mentioned because as iron increases, silica and alumina generally decrease. These must be fused along with iron and removed in smelting, and their removal requires more labor and fuel and decreases the iron output ratio of the furnace. The railway freight rate from Mesabi to upper lake ports is 55c a ton, and the lake freight is an additional 55c, including dock charges. Deducting freight charges at $1.10 the value on the Range of non-Bessemer ore of the grade mentioned is $1.70 and of Bessemer ore $2.30. Penalties are charged for ore below grade and premiums paid for that above grade.

By far the greater portion of the ores are shipped as they are taken from the mines; some, however, are crushed before shipping. At one plant they are dried, and in three plants the ores are concentrated by removing the sand and clay before shipping. The largest concentrating plant is near Coleraine on the west end of the Mesabi Range. The ore is passed with water through screens and washers and over tables which remove sand and clay. It has a capacity of about 3,000,000 tons of crude ore a season. A washing plant at Nashwauk treats 4000 tons of crude ore a day and a smaller one near Virginia treats 400 tons.

On all the ranges the principal iron mineral of the ores is iron oxide or *hematite*. In the original material from which the ore was derived the iron occurs chiefly as the carbonate, *siderite*, and the silicate, *greenalite*. On the east end of the Mesabi Range, near intrusions of igneous rocks, there is much *magnetite* in the iron formation. This material is too low grade to be marketed without previous concentration, and it is not now utilized. In St.

Louis and Cook counties there are deposits of titaniferous iron ore. With present furnace practice titanium is objectionable and these ores are not now marketed.

The Mesabi Range

Location.—The Mesabi iron district* is northwest of Duluth about 60 to 90 miles. In this region the most conspicuous feature is the ridge called the Giants or Mesabi Range. In the western part of the district this ridge is only 1,400 feet above sea level and not appreciably higher than the surrounding country. From Virginia eastward it is from 1,700 to 1,900 feet above sea level and some 400 feet above the surrounding country. The lower areas are covered with glacial drift, and much of the country is marshy and thickly wooded. Nearly everywhere the ore is concealed by from 20 to 200 feet of surface debris, except at the east end of the range where there are numerous exposures.

Discovery.—The presence of iron in the east end between Embarrass and Birch lakes was known to the earlier explorers, but the ore there is low grade and the rich ore was not discovered until 1890 when test-pitting by a crew employed by the Merritts of Duluth led to the discovery of rich ore near the present site of Iron Mountain. Soon afterwards, in 1891, W. J. Merritt discovered the Biwabik ore body.

Geology.—The ore occurs in a single sedimentary formation extending from a point about 12 miles southwest of Pokegama Lake, eastward about 100 miles to Birch Lake. At the surface this bed strikes about N.73°E., dips southward at low angles, and is from 1 to 3 miles wide. At Virginia and Eveleth there is a great loop in the iron formation which increases its exposure. The iron formation (Biwabik) is of pre-Cambrian age, belonging to the Upper Huronian series (Animikee). Below it is the Pokegama quartzite or older formations and above it is the Virginia slate. These three formations were laid down in water, one above the other, but afterward were elevated and tilted so that nearly everywhere they dip southward at low angles, about 15°. Their upturned edges are eroded to nearly the same level and covered with glacial drift which is in general from 20 to 200 feet thick.

Since at the surface the iron ore deposits are covered over with glacial

* Winchell, N. H., and Winchell, H. V., Geological and Natural History Survey of Minnesota: Vol. 4 Final Report, 1892-96, Vol. 5 Final Report, 1898-1900.

Winchell, H. V., The Mesabi Iron Range: 20th Ann. Rept. Geol. and Nat. Hist. Survey of Minn., 1893, pp. 111-180.

Spurr, J. E., Iron-bearing rocks of the Mesabi Range: Bull. 10, Geol. and Nat. Hist. Survey of Minn., pp. 1-268.

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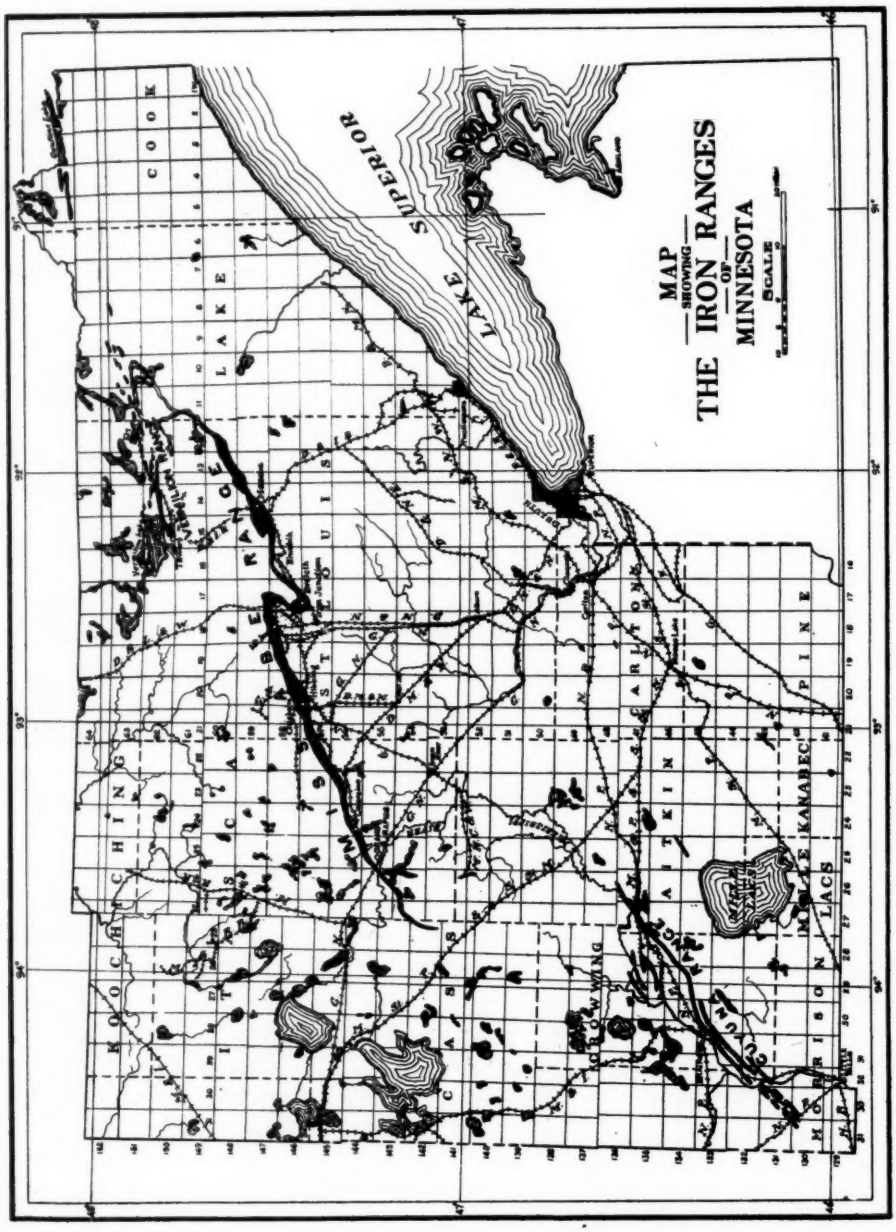
Van Hise, C. R. and Leith, C. K., Geology of the Lake Superior region: Mon. 52 U. S. Geol. Survey, 1911, pp. 159-197.

drift most of the deposits have been discovered by drilling. The iron-bearing bed, as already stated, is of sedimentary origin, but in its original condition it was not rich enough to work. By weathering or rotting at the surface the



materials other than iron are leached out leaving the iron oxide comparatively pure. Silica has been removed in large amounts and pore space has been developed through its loss. This leaching took place long before the glacial

period, and probably a considerable part of the iron ore was removed during glacial time. The average thickness of the iron-bearing bed is about 800 feet, but on account of its very low dip, the width exposed is in general from 1 to 3 miles. Only a comparatively small part of the upper surface of the iron formation is changed to iron ore.

Mining Methods.—The valuable deposits are confined practically to shallow depths. In many mines the ores are valuable not over 200 feet below the bottom of the overlying glacial drift and rarely ever do they extend downward over 400 feet. The length and breadth of the deposits are so great, however, that the amount of ore is very large notwithstanding its comparatively shallow depth. The drift capping is first removed and the ore, which for the most part is soft and powdery, is shoveled up by steam shovels and loaded directly into steel cars. Thus the mining costs are very low. In a few mines underground mining is carried on. The ore in them is recovered at greater expense, but not all of the ground lies favorably for surface mining on account of the great thickness of glacial drift or other barren material above the ore. The underground mines are worked also during the winter season, thus giving employment for some of the labor throughout the year.

The Vermilion Range

The Vermilion Range* is northeast of the Mesabi Range and extends from Vermilion Lake to Gunflint Lake on the Canadian boundary. It is about 100 miles long and in width it varies from 5 to 15 miles. Although the presence of ore in this range was known as early as 1850 the region was not extensively explored until 1875. The first ore was shipped from the Vermilion Range in 1884. The rocks are ancient schists, complexly folded and crumpled and the iron ore deposits are not so nearly continuous as they are on the Mesabi Range. Like the Mesabi ores they are surface concentrations of iron-rich sedimentary beds, but some of the Vermilion ores, after they were concentrated by weathering or surface decomposition, were buried under great thicknesses of later rocks and closely folded. Thus the ores which probably were soft and powdery like most of the ores of the Mesabi Range, have been converted by pressure into hard, heavy, iron ore schists. By reason of their close folding the ore deposits vary greatly as to depth. Although they were formed at the surface, some are now to be found many hundreds of feet below the surface, and deep mining is necessary to recover them. A few shallow pits have been dug on the Vermilion Range, but practically all of the ore is obtained from the deep shafts. Although the range is as long as the Mesabi, and somewhat wider, the ore beds are not so large and not so easily

* Grant, U. S., Winchell, N. H., and others: Geol. and Nat. Hist. Survey of Minn., Final Rept., vol. 4.
Clements, J. M., The Vermilion iron-bearing district of Minnesota: Mon. U. S. Geol. Survey, vol. 45, 1903.

mined. The district has been worked through a longer period but has produced only a little more than one-tenth as much ore as the Mesabi Range.

The Cuyuna Range

The Cuyuna Range* is west of Duluth and southwest of the Mesabi Range. It extends from the town of Aitkin southwestward through Deerwood, Crosby, and beyond Fort Ripley. It is at least 55 miles long and of undetermined width. The Cuyuna Range was the last of the Minnesota ranges to be discovered. The ore does not outcrop at the surface, but is covered over with glacial drift from 75 to 400 feet deep. The presence of magnetic rocks in this region was discovered about 1895 by Cuyler Adams, with a dip needle. The first drilling was done by Adams in 1903. The range has been prospected entirely by the use of the magnetic needle and drill. The iron ore is not itself magnetic, but is associated with magnetic formations and the location and strike of these beds below the surface is generally determined by magnetic surveys in advance of drilling. The ore deposits of the Cuyuna Range are in rocks that are approximately of the same age as the rocks of the Mesabi Range, but the formation which contains them is enclosed in the Virginia slate which, on the Mesabi Range, is above the iron formation. The workable deposits are steeply-dipping lenses which have a maximum width of about 500 feet. The average depth is about 300 feet, but some ores are found nearly 1000 feet below the surface. Locally, where the width of the ore deposits is sufficient, the glacial drift is stripped off by steam shovels and the ore is mined in open pits much as on the Mesabi Range. The drift is so thick, however, and the deposits are so narrow that a large part of the ore will probably be mined by underground methods.

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PEAT IN MINNESOTA

By E. K. Soper, University of Idaho
Recently of the University of Minnesota

IT has long been known that Minnesota contained large peat deposits, especially in the northern part of the state, but until recently little has been known regarding the quantity, character, distribution, or value of this material. In 1914 the Minnesota Geological Survey, in co-operation with the United States Geological Survey, began an investigation looking into the extent and value of the peats of Minnesota, and the results of this investigation will probably be published soon as a bulletin by the United States Geological Survey, for free distribution throughout the United States. This re-

* Leith, C. K., The geology of the Cuyuna Iron Range, Minnesota: Econ. Geol., vol. 2, 1907, pp. 145-152.
Adams, F. S., The Iron Formation of the Cuyuna Range: Econ. Geol., vol. 5, 1910, pp. 729-740.
Zapffe, Carl, and Barrows, W. A. Jr., The Iron Ores of the South Range of the Cuyuna District: Trans. Amer. Inst. Min. Eng., vol. 44, 1913, pp. 3-13.

port will include not only descriptions of the origin, character, and distribution of the peat deposits, but also chapters dealing with the various uses of the material and the methods and costs of preparing it for these uses.

Three Groups of Peat Deposits

In a general way, the peat deposits of Minnesota fall into three more or less distinct groups: (1) those in the northern part of the state, the so called "muskeg" swamps, the peat in which is formed chiefly of *sphagnum* or *peat moss;* (2) those in the central part of the state, formed sometimes in smaller sphagnum bogs, sometimes in open "wire grass" marshes, and sometimes in bogs which are combinations of both of these types; and (3) those in the southern part of the state which are always in open meadows and which never contain sphagnum.

The Northern Deposits

The sphagnum peat of northern Minnesota is by far the most important from the viewpoint of quantity as well as of quality. The largest deposits lie in the muskegs of St. Louis, Koochiching, Itasca, Beltrami, Roseau, Crow Wing, Aitkin, and Carlton counties. These swamps occupy, for the greater part of this area, portions of the old lake bed of the ancient Lake Agassiz which covered the region in glacial times and which has gradually dried up until today it has receded northward to Lake Winnipeg (Manitoba), a remnant of this former immense body of fresh water. As this great water area gradually disappeared, the newly exposed land, as would be expected, was without adequate drainage. The depressions and irregularities in the surface became the sites of small, shallow lakes or ponds around which there quickly sprang up a type of vegetation very similar to, if not identical with that which now fringes such ponds on low, marshy land. The areas around the shallow ponds were subject to inundation during the wet seasons and were kept constantly wet. Thus were brought about conditions favorable to the rapid growth of peat-forming plants.

As these plants died, their remains were prevented from decay by the excessive moisture which kept the region constantly wet. In this way large peat beds rapidly accumulated over much of this region and, in fact, are still accumulating in practically every muskeg swamp in northern Minnesota.

The most important peat former is sphagnum moss and it forms fully ninety per cent of the peat in the state. Where the peat has accumulated by the filling up of shallow lakes and ponds with vegetable remains, that part of the deposit which lies below the former water level of the lake is usually formed of plants other than sphagnum; the most important of these are pond weeds, lake bull rushes, cat tails, and various sedges. After the water has completely disappeared and a level mat of the remains of these aquatic plants is all that remains, the sphagnum soon crowds out all the other plant types and from that time on, the peat bed is built up layer after layer by successive generations of sphagnum.

There are, of course, numerous small peat deposits in this region,

especially in the southern part of it, which are not muskeg bogs, and which are formed largely from sedges and grasses. The greater portion of the peat areas of northern Minnesota, however, do not represent filled lakes, but built-up moist depressions, and from top to bottom are formed almost entirely of sphagnum.

The Central Deposits

The peat deposits of central Minnesota are in part identical in origin and history with those just described. However, sphagnum moss does not grow, except in rare, isolated occurrences, south of an east-west line drawn approximately through the cities of Minneapolis and St. Paul. Hence, north of this latitude, the peat is of the same general type as that of northern Minnesota; and south of it the peat is of an entirely different type; while along a belt twenty-five to thirty miles wide, near this dividing line, there are numerous deposits of each type, and sometimes deposits which represent combinations of both. The peat bogs of central Minnesota are not nearly so large as those to the north, but are much larger than those south of this region. The best and largest deposits lie in Anoka, Ramsay, Wright, Hennepin, Stearns, Sherburne, Isanti, Washington, Chisago, Millelacs, Douglas, and Pope counties.

The Southern Deposits

The peat of southern Minnesota is always found in open, treeless meadows or marshes, and is composed chiefly of sedges, grasses, cat tails, rushes, and other plants which are common to such an environment. The peat beds represent, in part, filled lakes and ponds, and partly built-up deposits on low undrained areas. They occupy the low land around the shores of lakes, or along river valleys, or merely low undrained depressions in the drift. They are usually small in area and shallow in depth compared with the peat bogs of the north, but nevertheless numerous deposits of commercial value exist, especially in Blue Earth, Nicollet, Le Seuer, Rice, Scott, Carver, Dakota, and Freeborn counties.

Quality

The quality of the Minnesota peat, especially that from the northern portion of the state, compares very favorably in its fuel value with that from any part of the world. Some of the European peat is more decomposed and contains less ash and hence contains more heat units pound for pound. On the other hand, a large part of the peat used commercially in European countries, especially that in Sweden, Denmark, Germany, Russia, and Switzerland, is formed from the same plants in the same way as that found in Minnesota, and is almost identical with it in its composition and physical properties.

As to the quantity of peat in the state, it is not yet possible to give even approximate figures. An idea of the vast amount available may be gained, nevertheless, from the fact that one of the northern bogs is nearly one thousand square miles in area, over which the peat is *at least* seven feet thick. On the assumption that 200 tons of air-dry machine peat can be made per acre for

each foot in depth, this bog alone contains approximately 896,000,000 tons of air-dry machine peat fuel.

Use

It seems probable that the most profitable commercial use which can be made of the peat in Minnesota at the present time is the manufacture of power in peat producer-gas plants. This has been highly successful in a number of large plants in Europe, and there seems to be no reason why their success can not be duplicated here. As the rapidly diminishing timber supply of northern Minnesota becomes exhausted, peat will be used more and more for fuel. Already the coal resources of the United States have shown great depletion, and in the near future we may expect to see the beginning of this new industry—the manufacture of machine peat for domestic fuel.

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THE CLAYS OF MINNESOTA*

By F. F. Grout
University of Minnesota

WHILE the clays of Minnesota play a subordinate part in her mineral resources, due to the importance of iron ore, there is in the state a noteworthy industry based on a considerable variety of clays. Furthermore, a careful study of the materials and a search for deposits now concealed, may lead to notable developments in the future. Even now the clay industry in Minnesota involves from one and a half to two million dollars annual production, a large part of which is pottery and sewer pipe from the deposits near Red Wing. Common and fancy brick are produced in all parts of the state, and no better building material can be found than is made within the state.

Near Red Wing the clays are light gray, and banded, and were accumulated in Cretaceous time. Later geologic events have disturbed them somewhat, and to some extent, isolated the relatively small parts of a large formation. Smaller fragments of the same formation are known in other places in the neighborhood. Much of the clay needs washing, before it is in condition for use in making stoneware, as it contains some coarse and dark-colored minerals. Sewer pipe are made from the poorer grades of clay in the same deposits, and for these, no washing is needed. The thickness of the clay deposit is variable, rising to a maximum of over 40 feet, though many layers of sand are interbedded. The clays used at Red Wing are shipped in a few miles from Clay Bank and Belle Chester.

The Decorah Shale.—There is a large shale formation—a hardened clay—of very different character, extending from the vicinity of St. Paul, south and southeast. This is known as the Decorah shale, from outcrops at Decorah, Iowa. It is a green shale, and likely to be contaminated with lenses

*Acknowledgements are hereby made to Bulletin 11, Minnesota Geological Survey, "The Clays and Shales of Minnesota," by Messrs. Grout and Soper.

and layers of limestone. Most of it is very fusible, and the burned product is colored by the iron it contains. However, the process of fusion is gradual and if it is carefully controlled, brick and tile can be burned to a very dense vitrified product. At West St. Paul, many fancy-front brick and "klinker" brick are produced with a large assortment of handsome colors.

Other Deposits.—The other bed rock formations of the state which have ceramic interest are: more fusible Cretaceous shales known at Springfield and New Ulm; the residual kaolins of the Archean and Huronian; and the somewhat metamorphic slates. It is thus evident that while Minnesota has not extensive refractory shales, that compare with those of Illinois and Ohio, there are large formations capable of making excellent ware.

These are the clays of the state, which, having been formed by some mineral alteration in early geologic ages, and having accumulated in beds of considerable thickness, were incorporated in a series of rock formations, often associated with sandstone and limestone. If they were covered by a great weight of overlying beds they were hardened into shale, but this does not prevent their use as a clay. Unfortunately for the development of these clays in Minnesota, more recent geologic events have spread a mantle of debris over most of the bed rock clays and they are rarely seen except in the gorges of the rivers.

The Glacial Drift.—The concealing mantle, however, has in itself some interest as a clay. It is the glacial drift brought into its present neighborhood by the action of a great continental glacier. This ice sheet entered the region from two or three directions, and on its way gathered in portions of the clay beds it crossed. These clays, mixed with sand and rock, now form the drift mantle. Scarcely a county in the state lacks drift clays that can be manufactured into common brick.

A large part of the state received a cover of *gray drift,* material which came from the northwest and which contains a high proportion of lime. The texture and physical state of this lime has been the decisive point in the success or failure of the attempts to use the clays of the drift. If the lime is in the form of pebbles, there is difficulty in making good brick without an expensive treatment to counteract their effects. However, along the rivers and in some of the lakes, Nature has done the preliminary washing and clays of the gray drift have been freed from pebbles. These make excellent cream colored brick and fireproofing. Where the demand for brick and drain tile warrants it, an artificial process can be conducted so as to yield good results; as, for example, at Hutchinson. Some other methods of utilizing the gray drift have at least partially succeeded; and attempts have been numerous, because of the large amounts of the clay in easily accessible places.

In the northwest quarter of the state this drift was once flooded by a glacial lake—Lake Agassiz,—and its deposits, as well as those of the Red River, now draining the area, are of a slightly different type. The clays, however, have the same defect, the small fragments of limestone.

In the eastern and northeastern quarter of the state there is a superficial

deposit of *red drift* which is radically different from the gray. A much smaller proportion of the drift is clay, and when clay occurs, it contains pebbles, not of limestone but commonly of granite and related rocks. These do not have so serious an effect as the limestone, which may slake and swell after burning, but the clay is, of course, improved by their removal. A large plant at Coon Creek, near Minneapolis, is using the red drift clay, after passing it through conical rolls to remove pebbles. The product is an excellent grade of hard red brick, for the clay can be safely vitrified. In the few places where Nature has washed the pebbles from this red drift clay, the resulting clay is extremely plastic and shows such a high shrinkage as to make it difficult to manufacture. It yields good vitrified products, however, as shown by its use at several plants in Wisconsin. Such clay is abundant around Lake Superior and along the St. Croix River.

In a few places, notably at Wrenshall, and along the rivers farther south, washed clays have been mixed by natural processes, being derived partly from the gray and partly from the red drift.

In the southeastern corner of the state there is an area in which are many deposits of *loess,* a material derived by some process of working over and assorting surface material. The loess is used at Preston and elsewhere for excellent red brick.

MINNESOTA

ROCK QUARRYING INDUSTRY IN MINNESOTA

By T. M. Broderick
University of Minnesota

THE stones quarried for building purposes in Minnesota are chiefly granite, sandstone, and limestone. The limestone area is mainly in the southeasten part of the state, along the Mississippi river, and westward to the middle and southern parts of the state. The sandstone occurs along the western boundary of the limestone area, in the southwest corner of the state, and near Lake Superior. The important granite producing areas are along the upper Minnesota valley at Ortonville and Redwood Falls, and in the section centering about St. Cloud. As most of the state is covered with drift the quarries usually occur along the sides of the valleys where the streams have exposed the bed rock.

The region in Stearns, Benton, Sherburne, and Kanabec counties, but centering mainly about St. Cloud, is the largest granite producing area in the state. Here pink, red, and gray granites are quarried. The coarse grained pinkish-gray granite in the basement of the new capitol at St. Paul is from the St. Cloud quarries. The red stone is used for polished monumental works, pillars, and columns. The gray stone is used for monuments, building stone, curbing, and paving blocks. In the vicinity of Ortonville a dark red granite is quarried which is being used extensively in the Twin Cities.

In the southwestern corner of the state a quartzite, locally called granite

on account of its hardness, is quarried. It is taken out in Rock and Pipestone counties, and there is another area centering at New Ulm. This quartzite is used for building material near where it is quarried, but its largest use is as crushed stone for road construction. On the Kettle river at Sandstone, Pine County, a fine grained, light pink sandstone is quarried. The quarry is operated on a large scale and has all the facilities for a large output of stone. The principal products of this quarry are building stone, crushed stone, sawed stone, rubble, paving blocks, curbing, bridge stone, coping, and monument bases. The library building at the University of Illinois is built of this stone. The use of the Kettle river sandstone for building purposes is widespread. A brownish red sandstone is quarried at Fond du Lac, near Duluth, in St. Louis county. At Jordan, Scott county, a light colored sandstone is quarried.

The limestone quarried in southeastern Minnesota is mostly of two geological ages. The older is high in magnesium but the younger is comparatively pure calcium carbonate. The beds of each sort are horizontal and range in thickness from a few inches up to two feet. The stone is usually blue when fresh but turns to a buff on exposure. It is quarried at Kasota and Mankato for building stone and for natural cement; at other places for crushed stone and lime manufacture. Along the Mississippi it is used extensively for riprap.

The Mankato and Kasota quarries are in high grade magnesium limestone that can be tool faced, carved, and polished. The Mankato stone is of a buff color, and that at Kasota is of a light pink shade. That at Mankato is used largely for massive masonry and crushed stone. The Kasota stone is used for flagging and building purposes, such as polished wainscoting. Much of the wainscoting of the new capitol at St. Paul is of polished Kasota stone.

Limestone quarries are opened also at Rochester, Mantorville, Faribault, and Minneapolis. Most of the stone taken out in these quarries is used in the form of rubble and crushed rock. Lime is burned from local stone in Blue Earth, Fillmore, Goodhue, Mower, Rice and Scott counties.

The output of stone in Minnesota for the year 1912 was as follows: Granite, $950,000; limestone, $546,000, and sandstone, $349,000. These totaled $1,845,000. Minnesota ranked twelfth as a stone producing state in that year.

MINNESOTA

Land Values

In 1910 the average value of land in Minnesota was $46 per acre; in Iowa it was $95.96 per acre, and in Illinois $108.13, more than twice as much, in each case, as in Minnesota. At these prices, 160 acres—which in Iowa would cost $15,360, and in Illinois $17,280—could be bought in Minnesota for $7,360.

THE DEVELOPMENT OF THE LUMBER INDUSTRY IN MINNESOTA

By E. G. Cheyney
University of Minnesota

WHEN the Pilgrims landed in Massachusetts in 1620 they encountered a forest running down almost to the very water's edge, and extending far back into the unknown interior. Coast as they would along the sea and up the rivers, the forest was everywhere ahead of them. Every acre of ground needed for their modest homes and tiny fields had to be wrested from the forests by ceaseless labor and from that same forest came their enemies,—wild animals and Indians. It became for the time the dragon guarding the apples of the Hesperides. It had to be destroyed that the people might live.

Ever mindful of the possibilities of trade, these early Yankees began shipping the choicest timbers to England, and thus began the logging industry in America. It was a small beginning for the ships were few and far between, but it grew apace as colonists rapidly increased in numbers and concentrated in towns where each man could no longer cut all the timber he needed in his own backyard.

For a hundred years these people lived on the Atlantic Coast literally hewing an empire out of the forest. They had prospered and multiplied beyond all belief. There was no longer any question of their ability to hold their own against the forests; they were completely master of the situation and were seeking new fields to conquer. Irresistibly they forced their way over the mountains and came in due course of time to the pine forests of Michigan. The hardwood forests were for settlement, but the forests of pine were to log, and among those hardy pioneers were experienced loggers trained in the forests of Maine. No one knew better than they the wonders of that forest.

Only one thing was lacking, a market; there were not enough people on the western side of the mountains to buy the lumber. This could not long hinder such ardent enterprise and the industry was triumphantly opened with the successful rafting of logs to the distant settlement of St. Louis on the far away Mississippi. Inevitably lumbering became the leading industry of Michigan, as it has been in turn the leading industry of every forested state in the Union.

The Early Lumber Industry

Settlement swept on to the westward, and two hundred years after the first white men had landed on Plymouth Rock the first wavelets of the great tide of civilization were lapping the southern half of Minnesota. In 1821 Fort Snelling was built at the junction of the Minnesota and the Mississippi, and to supply the timbers for this Fort, the first sawmill was built in the state at St. Anthony Falls; the logs were cut in the Dutchman's Grove and on the lower Rum River. This, however, must be considered as a purely sporadic

development, for the settlement of the state did not begin in earnest until the Chippewa Indians ceded that portion of the state east of the Mississippi River to the government in 1837. Once that settlement was begun the lumber industry took the lead as a matter of course. No sooner were the preliminary negotiations for the cession of the triangle of land between the Mississippi and the St. Croix under way than the first land seekers made their way up as far as the falls of the St. Croix, and located a site for a sawmill at Marine. A sawmill and all the necessary equipment was brought up on a chartered boat from St. Louis and the first lumber was sawn August 24th, 1839. This was the first commercial sawmill in Minnesota. It was a small waterpower mill with crude machinery and a capacity that would be put to shame by many of the portable mills of today; but it prospered and continued to operate uninterrupedly for fifty years, during which time it manufactured a total of 197,000,000 board feet of lumber.

Five years later, 1844, the first sawmill started operations at Stillwater which quickly developed into the leading lumber town of Minnesota. In fact it was generally considered at that time that Stillwater was destined to be the largest city in this section of the country. In the next ten years five more mills were built in and immediately around the town.

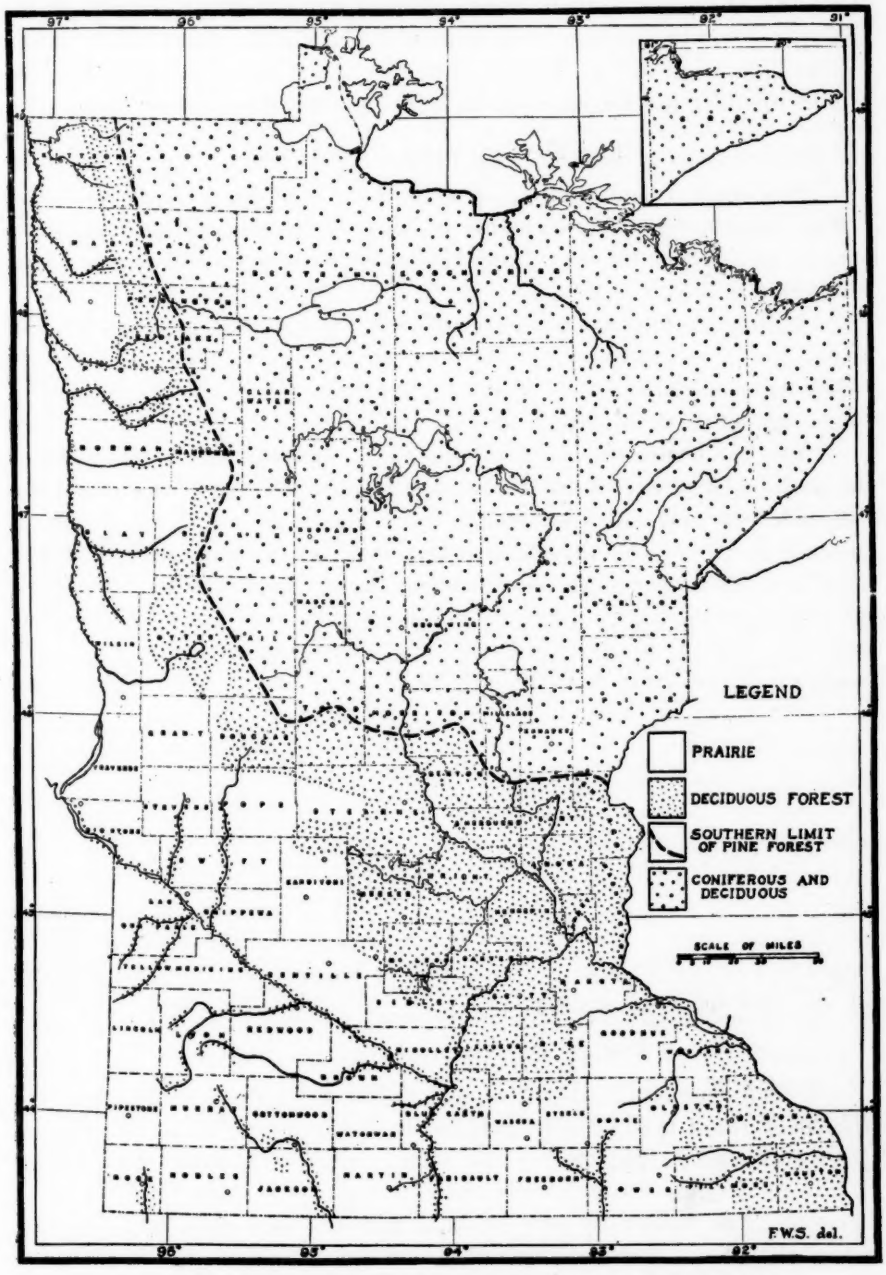
Obviously there was a market for comparatively little of this lumber in Minnesota, for the total population in 1850 was little over 6000. But in 1843 an accident pointed the way to a tremendous increase in the logging industry of Minnesota. The great log boom at Stillwater broke, and the whole winter's cut of logs was scattered down the Mississippi River as far as St. Louis. This was the beginning of the great log rafting on the Mississippi that leads to the development of sawmills at Red Wing, Wabasha, Winona, Dubuque, Galena, St. Louis, and many other points on the river. Practically all of them were supplied with logs from the upper Mississippi and St. Croix valleys.

The Beginning of Minneapolis as a Lumber Center

Thus it was that logging and milling was a well established business in the St. Croix valley when Mr. Franklyn Steele, who held the claim which controlled the waterpower at the Falls of St. Anthony,—the present site of the Minneapolis flour mills—built a sawmill in 1848 to tap the pine forests of the upper Mississippi. It was a rather precarious undertaking, for this section was yet in the hands of the Indians, and each operator had to bargain with them for the timber he wanted to cut.

The nearest large body of pine was found at the Rum River near Princeton in 1847, but the logs cut were lost in the Mississippi by the breaking of the boom. The next winter, 1848, the first logs to be sawn at the first Minneapolis mill were cut at the mouth of the Crow Wing. The timber was bought from Chief Hole-In-The-Day for 50c per tree.

So rapidly did the logging in this section develop that the 1½ million feet cut the first year had increased to nearly 9 million in 1851 and to 44



Map of Minnesota Showing Distribution of Forest and Prairie.
(From Bulletin 12, Minnesota Geological Survey)

million in 1857. Logs became the medium of exchange. Merchants in St. Paul and St. Anthony Falls—which later became Minneapolis—supplied the mills and logging crews and accepted logs in payment. These they rafted to

St. Louis and other southern towns. It was a long time credit account, for the money was very often not received until a year later. Everyone, whatever his business, dealt in logs, and the millions of dollars brought into this country by the trade was largely responsible for the rapid development of the state.

The Development of the State

The Rock Island Railroad reached the Mississippi at Rock Island in 1854, bringing thousands of people to Minnesota and greatly enlarging the market for logs and lumber. From 1850 to 1856 the population jumped from 6000 to 100,000.

Rapidly the logging crews worked their way up the Rum River to Mille Lacs and beyond, up the Crow Wing to the limits of its pine, and on up the Mississippi and out to the limits of its northern tributaries. By 1860 they were logging north of Little Falls.

Yet, the settlement of Minnesota was progressing under a tremendous handicap. There were no railroads. For half the year, while navigation was suspended, the state was commercially isolated from the rest of the world. It was not until 1867 that a railroad at last connected Minneapolis with Prairie du Chien and made the Minnesota metropolis an all year market. Hundreds of miles of railroad were completed in the next few years linking Minneapolis with the head of the lakes, and stretching westward into the prairies. The population grew from 439,000 in 1870 to 1,117,000 in 1885. Up to this time extensive development had been confined to the country within easy reach of the rivers. This had been especially true of the lumber industry, because the products were too bulky to be transported overland by wagon.

Another important result of the railroad building was the marvelous growth of flour milling in Minneapolis. As early as 1875 the flour mills displaced the sawmills as the leading industry. That was in Minneapolis, but not in the state as a whole. The railroads helped the loggers quite as much as they did the flour mills. The timber back from the driveable streams began to melt away before this new form of logging, and the lumber output of the state increased steadily.

The Rise of the Great Lumber Companies

Under these conditions there could be but one form of ownership. No one could afford to build a railroad for logging purposes unless he owned a large quantity of timber to log and a large mill to consume the product. Hence the logging was gradually concentrated in the hands of a few large operators, who build their own railroads and their own mills, and own vast tracts of timber. The small operator, with few exceptions, has disappeared; either left the country or is working under contract for the larger companies.

There was, however, one class of operators too small to be affected by these changed conditions, in fact it has thriven and has been increased by them. These were the *portable mill* owners. The large operators with their elaborate equipment have cleared large tracts of land and in the clearing of

these tracts have, for one reason and another, left small isolated patches of timber. Too small to support a permanent mill and located at prohibitive distances from the large mills, these patches can be handled profitably only by the portable mill. Moreover, much timber which was not considered merchantable at the time of the big operation now has a good market. Consequently we find almost countless portable mills working in what are known as cut-over lands.

The lumber output of Minneapolis had reached 678 million feet in 1899, but the bulk of the milling had already passed to the northern towns. The extension of the railroad from Minneapolis to Duluth in 1870 had boomed the latter, and a sawmill was started in West Duluth the same year. Others followed. The logging in Michigan and Wisconsin reached a climax between 1890 and 1900 and declined rapidly. This opened an inviting market for the timber tributary to Duluth. Chicago and North Tonawanda—the largest distributing point for the East—were both within easy reach by water. Millions of feet of Minnesota lumber passed out this gateway to the "Soo" and beyond. Most of the mills within reach of the lakes still saw a certain amount of full thickness lumber for this cargo trade.

The Northern Mill Centers

Falls in the St. Louis River at Thompson interfered with the free driving of logs to Duluth and the first mill was established in Cloquet in 1878. Four others followed in later years. When the cut of Minneapolis began to decline, Cloquet became the largest manufacturer of pine in the state, and it still holds that position. A logging railroad has been built from Cloquet to the Iron Range at Hornby, and this road together with the St. Louis and its tributaries, taps a vast country.

Other mills appeared as opportunity offered along the line of the Great Northern Railroad at Carleton, Scanlon, Grand Rapids, Deer River, Cass Lake, Bemidji, Walker, Akeley, and many other places. Around most of these centers the settlement of the country has lagged so far behind the logging that most of the product was shipped out of the country to a distant market. Where agricultural development has come later, lumber has been shipped in from some more distant frontier to supply its needs.

There is still another section which has had a slightly different development; the country tributary to the streams which empty into the boundary waters to the north. It is this section which is now supplying most of the logs to the present sawmills. A portion of it is reached by the railroads. The mammoth mill at Virginia, for instance,—the largest mill in the state, gets its logs by rail from this northern section, and distributes its lumber in the same way to all parts of the country. Other mills at Baudette, Spooner, and International Falls draw their supplies from this section, down the rivers as well as by rail.

The Pulp and Paper Mills

A large supply of spruce and balsam in the northern part of the state at-

tracted another industry, closely allied to the lumber industry and yet different from it, the pulp and paper mill. The big sawmill with its insatiable appetite is essentially of a temporary character. It is impossible to keep it economically supplied with logs for a long period of years. Moreover it represents a comparatively small capital. The paper mill on the other hand usually represents a very large investment and can be supplied with wood in perpetuity from a comparatively small tract under the proper management. The manufactured product is compact, free from waste, and consequently can be shipped for long distances.

Under these conditions paper mills grew up at Cloquet, Grand Rapids, Brainerd, Sartell, and International Falls. Most of the mills grind up the wood and manufacture what is known as mechanical pulp, such as is used for the cheaper grades of print paper; but at International Falls and Cloquet sulphite mills have recently been installed for the manufacture of chemical pulp for high-grade papers. Spruce is the chief species used by these mills now, with a certain percentage of balsam mixed in, but the chemical mills are capable of using other species.

Logging Methods

In some cases where the railroad has not penetrated and the timber is located near the stream, the logging methods have changed very little since the first logs were taken out in 1838, except that the saw has replaced the axe in felling the trees and the horses have crowded out the oxen on the sleigh hauls. It is what is known as the "snowball" system. The trees are felled and trimmed. The front end of the logs are chained on a single bobsled and with the rear ends dragging on the ground, are dragged to the stream, there to wait the spring break-up. As the haul from the woods to the stream increased, it was necessary to find some method by which the larger logs could be handled. The iced road was the solution. By sprinkling, the sleigh ruts were converted into grooves of ice, and by supporting the whole log on double sleds the loads were trebled, and in many cases more than that.

This is the method in almost universal use in Minnesota today. In a few cases where the railroad can be easily built and the stand of timber is particularly heavy, the overhead steam skidder in common use in the South, has been introduced in the past five years. It consists of a heavy cable stretched between two large trees for 900 ft. On this is an inverted bicycle like that used to carry the cash baskets in the stores. A lighter cable passing through this bicycle is operated by a stationary engine on a flat car. The logs are picked up by the cable wherever they are felled and carried to the cars for shipment to the mill. This method has proven very satisfactory under the present conditions, but can be used only on large scale operations where the timber is heavy.

The Forests of Minnesota

The original forest area of Minnesota has been estimated at 33 million acres. This included the Big Woods, or hard wood forest which extended

south from the mouth of the Crow Wing to the southern boundary and west to the prairies, and the pine forests which were scattered over the northern two-thirds of the state east of the prairies. This is ten per cent larger than the estimated forest area of Michigan and almost 30 per cent larger than that of Wisconsin. But the stand of timber is not so good and the total output of lumber from this state will never equal that from either of the other two.

The Hard Wood Forests

The Big Woods have furnished comparatively little timber to the lumber industry. Hardwoods are used more for specialties, and the market for them is not developed in a new country until the settlement is pretty well established. In the case of Minnesota, a large portion of this land was cleared for farming long before there was any market, and the timber was burned to get rid of it. To be sure there is a considerable portion of this section still under timber, but it is in very small patches, and most of it has been heavily culled of its most valuable trees for local purposes. What little of it now reaches the market does so through manufacturing plants which turn out finished products, and not through the sawmills. On the whole, it may be said that it never has and never will support a lumber industry worthy of the name, and so deserves little more than an honorable mention in this article.

The Pineries

It is the great pineries of the north with which we are chiefly concerned. Coming down to meet the Big Woods north of the cities, they covered the whole of the northern end of the state east of the prairies. The great bulk of it was a mixture of white and Norway pine. Almost everywhere there was some jack pine mingled with it, and this percentage increased on the sandier lands until the jack pine occasionally formed the bulk of the stand or even formed a pure stand itself on limited areas. Almost everywhere there was a sprinkling of the northern hardwoods, such as birch and popple, and these in turn on the heavier soils alone, mixed with other more valuable hardwoods, or, in the more northern counties, mixed with the spruce and balsam, occupied the ground to the exclusion of the pines.

Minnesota's lumber output reached its highest point in 1905, with about two billion feet, and has since then steadily declined. So rapidly and mightily did her lumber industry grow that just sixty-seven years after the first commercial sawmill had been built within her borders her "inexhaustible timber supply" was on the wane. Never again will the industry attain to the proportions it had in 1905; but, on the other hand, never will it die out. New and possibly inferior species will be forced into use, while the second crop of pine is growing to merchantable size, but a lumber industry there will always be. Part of it at least, the manufacture of paper and pulp, is likely to increase steadily, and, in time, take a prominent place in the industries of the state.

AGRICULTURE IN MINNESOTA

By Geo. J. Miller
State Normal School, Mankato

AGRICULTURE is the most important single industry in Minnesota. Suitable climate and suitable soil are two essential requirements for agriculture. Other factors influence the rapidity and intensiveness of development in a given region, especially such factors as transportation facilities and

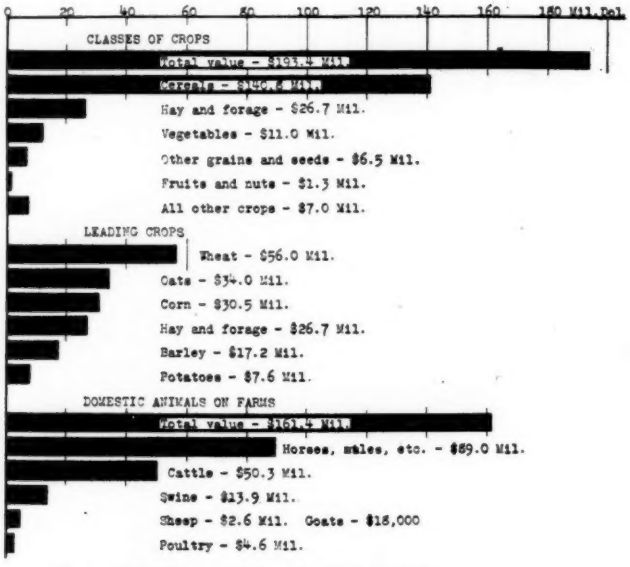

0 20 40 60 80 100 120 140 160 180 Mil.Dol.
CLASSES OF CROPS
Total value - $[illegible] Mil.
Cereals - $[illegible] Mil.
Hay and forage - $26.7 Mil.
Vegetables - $11.0 Mil.
Other grains and seeds - $6.5 Mil.
Fruits and nuts - $1.3 Mil.
All other crops - $7.0 Mil.
LEADING CROPS
Wheat - $56.0 Mil.
Oats - $34.0 Mil.
Corn - $30.5 Mil.
Hay and forage - $26.7 Mil.
Barley - $17.2 Mil.
Potatoes - $7.6 Mil.
DOMESTIC ANIMALS ON FARMS
Total value - $161.4 Mil.
Horses, mules, etc. - $89.0 Mil.
Cattle - $50.3 Mil.
Swine - $13.9 Mil.
Sheep - $2.6 Mil. Goats - $18,000
Poultry - $4.6 Mil.

Fig. 1. Summary of Minnesota Agriculture for 1909.

markets. All the above factors, the dairy industry, and horticulture are considered in other articles, hence this discussion is limited more particularly to a brief summary of the leading crops and agriculture as a whole.

Agriculture in General

The general distribution of agriculture in the State is presented clearly by Figures 2, 3, 4, and 5, which show the distribution of the value of farm property; of all crops; number of all live stock on farms; and the percentage of land area in farms. It is evident that the most highly developed parts of the State are the southern half and the northwestern or Red River Valley section. The northeastern part is developed but partially, large portions being wholly undeveloped agriculturally. The southern section corresponds to the grey drift and prairie soils, the northwestern section to the lacustrine soils of Lake Agassiz, and both sections correspond to the more favorable climate of the State. The northeastern section includes the forest and cut-over lands,

light or rocky soils, and extensive swamp areas. The level land, rich soils, and favorable climate of the Red River Valley offered excellent opportunities for the growth of cereals, especially wheat, and was settled early in the history of the State. Only within recent years has agriculture become more diversified in that region. The advanced development in the northern half is

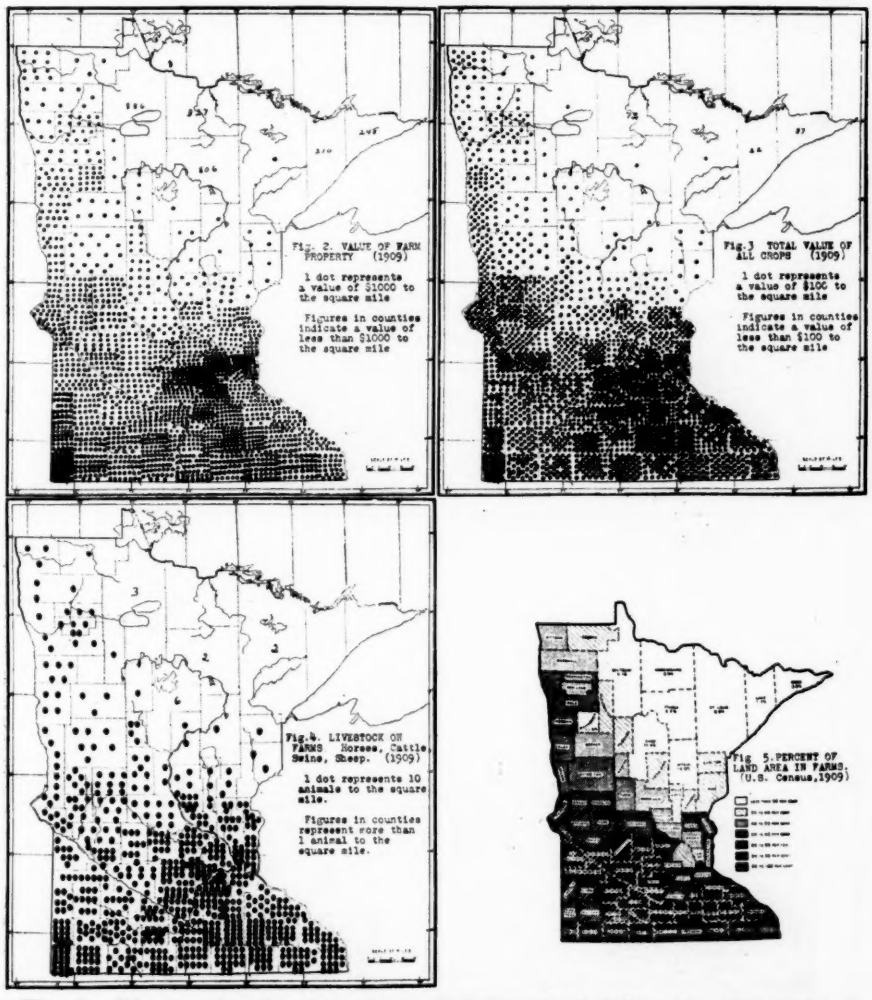


Fig. 2. VALUE OF FARM PROPERTY (1909)
1 dot represents a value of $1000 to the square mile
Figures in counties indicate a value of less than $1000 to the square mile
Fig. 3 TOTAL VALUE OF ALL CROPS (1909)
1 dot represents a value of $100 to the square mile
Figures in counties indicate a value of less than $100 to the square mile
Fig. 4. LIVESTOCK ON FARMS Horses, Cattle, Swine, Sheep. (1909)
1 dot represents 10 animals to the square mile.
Figures in counties represent more than 1 animal to the square mile.
Fig. 5. PERCENT OF LAND AREA IN FARMS. (U.S. Census, 1909)

Fig. 7. Figures showing important agricultural statistics for Minnesota.

due in part to the fact that it was settled first and to the easy occupation and cultivation of the open prairies after they were opened to settlement. The poorer soils and forest covered portion in the northeast was passed by until the more desirable areas elsewhere were occupied.

The importance of the southern portion of the State is made evident by comparison with the State as a whole. In the area south of a line drawn east from the southern end of Lake Traverse is produced 72.6 per cent of all crops, measured by value; it has 77.4 per cent of the value of all farm property; 77

per cent of the value of all live stock on farms; 71 per cent of the improved land in farms; 69.3 per cent of the total population and all cities (except Duluth) of more than 11,000 inhabitants.

Cereals were the pioneer crop in southern Minnesota as in most newly settled regions of the United States. Wheat was the chief crop. During the

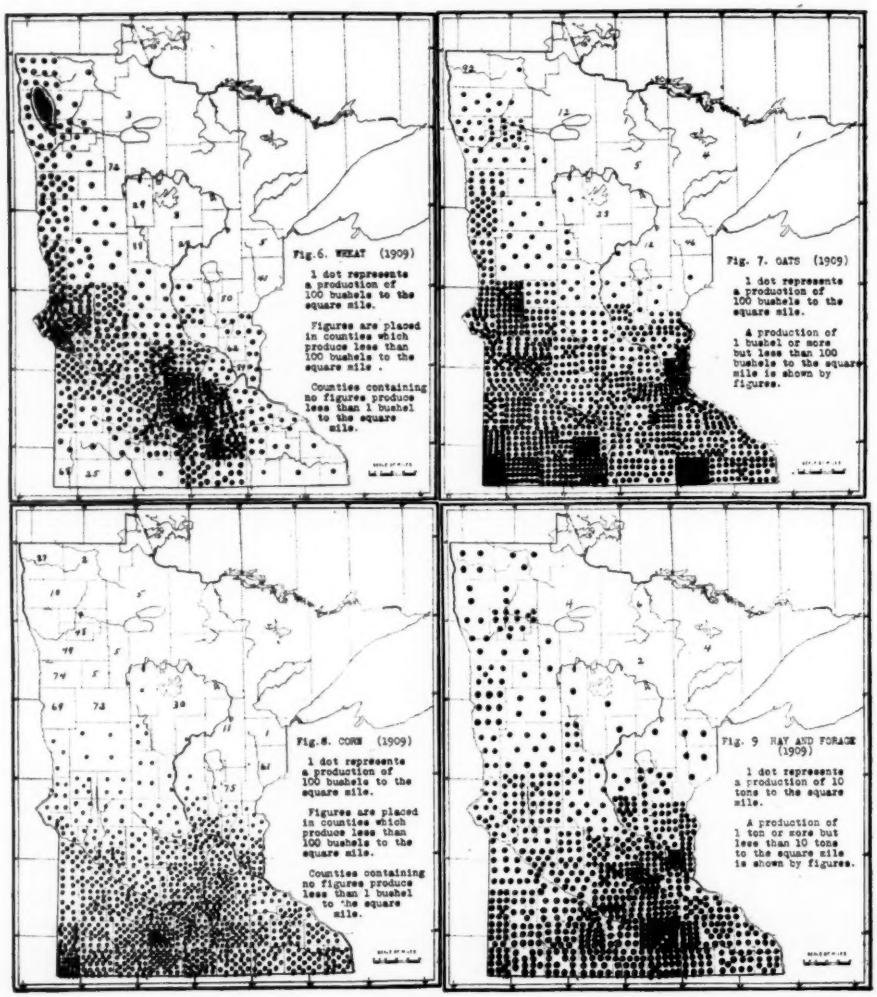
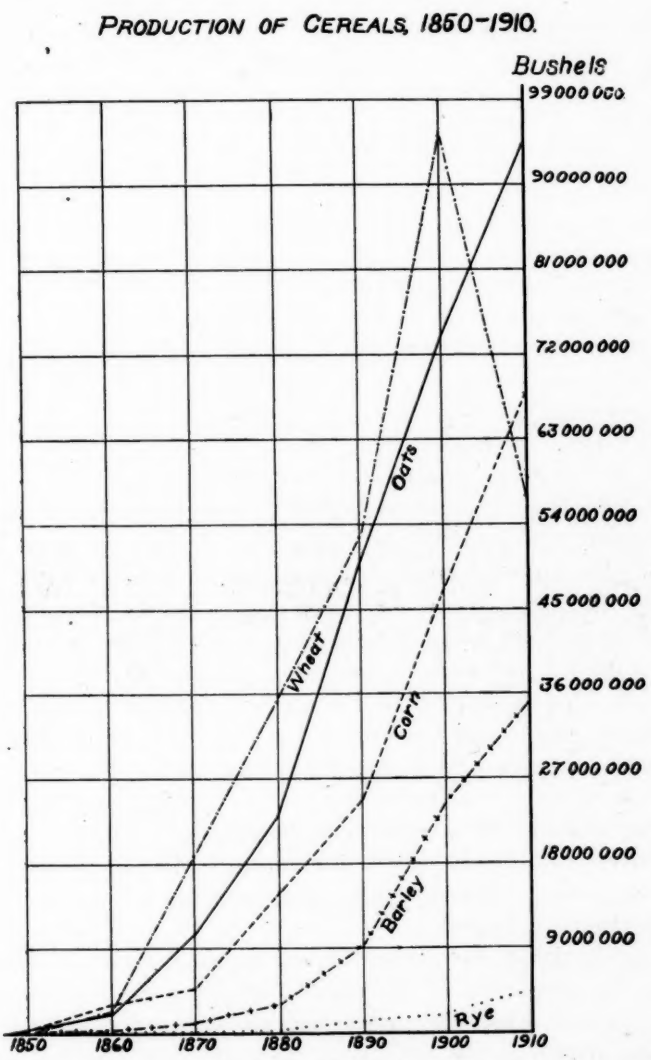


Fig.6. WHEAT (1909)
1 dot represents a production of 100 bushels to the square mile.
Figures are placed in counties which produce less than 100 bushels to the square mile.
Counties containing no figures produce less than 1 bushel to the square mile.
Fig. 7. OATS (1909)
1 dot represents a production of 100 bushels to the square mile.
A production of 1 bushel or more but less than 100 bushels to the square mile is shown by figures.
Fig.8. CORN (1909)
1 dot represents a production of 100 bushels to the square mile.
Figures are placed in counties which produce less than 100 bushels to the square mile.
Counties containing no figures produce less than 1 bushel to the square mile.
Fig. 9 HAY AND FORAGE (1909)
1 dot represents a production of 10 tons to the square mile.
A production of 1 ton or more but less than 10 tons to the square mile is shown by figures.

past decade and a half diversified farming has become more widespread with special emphasis upon live stock, the dairy industry, and the production of stock food. With diversified farming, increased population, better markets and transportation facilities, land values have increased greatly. This condition has stimulated settlement of the northeastern part of the State. During the decade 1900 to 1910, 55 per cent of the counties of southern Minnesota (south of the previously described line) declined in rural population, the decrease averaging nearly six per cent and varying from one-half of one per cent

to 12.4 per cent. Many of the people who left the farms of this section went to the cities, others left the State, while others sold their farms at the high prices prevailing and bought more land in the northeastern part. This section, therefore, has experienced the most rapid growth of any part of the State outside of the cities. Even with this rapid growth, however, the northeastern



Production of principal cereals in Minnesota, 1850-1910. (From Robinson's "Economic History of Agriculture in Minnesota." University of Minnesota Studies in the Social Sciences, Number 3.)

part is very sparsely settled and much of it must always remain sparsely settled, because it is best adapted to forest culture. The State as a whole is only partially developed agriculturally. In the southern section 80 to 100 per cent

of the area is in farms, in the northwestern section 40 to 80 per cent, and in the northeastern section less than 40 per cent (Figure 5). Seventy-one per cent of the farm acreage is improved, which represents only 38 per cent of the land area of the State. Although the improved acreage is small compared with the entire area it is approximately equal to the land area of Connecticut, Massachusetts, Vermont, and New Jersey combined, and to more than one-fourth the area of the British Isles.

Leading Crops

The general character of agriculture of the State is shown by the fact that nearly three-fourths (72.8%) of the total value of crops is contributed by the cereals (Figure 1) and about one-eighth (13.8%) by hay and forage. The remainder consists mostly of potatoes, other vegetables, and forest products. Measured in terms of value the leading crops are wheat, oats, corn, hay and forage, barley, and potatoes. The cereals have an acreage more than two and one-half times that of hay and forage and a value more than five times as great. More than one-fifth of the improved land of the State is devoted to the production of hay and forage, about one-sixth to wheat, a little less than one-sixth to oats, more than one-tenth to corn, and nearly one-twelfth to barley.

King Wheat reigned supreme in Minnesota for more than forty years. As late as 1900 more than one-half (50.69%) of the cultivated land was devoted to wheat, but by 1910 the acreage had declined to about one-fourth (25.7%). The largest decrease in acreage was 95 per cent in the southwestern part of the State. In the Red River Valley the decline ranged from 30 per cent to 50 per cent during the same period. With the loss in wheat acreage came a marked increase in that of corn, oats, hay and forage, barley, rye, and potatoes. Nearly as much land was devoted to oats in 1910 as to wheat and the former may become the leading crop. Probably most significant is the increase in the area devoted to hay and forage, as this indicates rotation of crops and an increase of animal industries (See article on dairy industry). The present wheat growing region is in the drainage basins of the Minnesota and Red rivers as is clearly shown in Figure 6. Most of the crop is a high grade spring variety although winter wheat is being introduced as the yield per acre is ordinarily larger.

The production of oats, corn, hay and forage is shown in Figures 7, 8, and 9, and the production of live stock is intimately associated with these crops (Figure 4). There were three principal oat districts in 1910, viz., the high Coteau section in the southwest, the high plateau section of Mower County in the southeast, and about the Twin Cities. The development of the first two sections is probably due to the fact that oats give better yields than most other cereals where the nights are cool. Owing to the bulky character of oats the crop usually pays best near large city markets, which probably accounts for the development of the section about the Twin Cities. South-central and southwestern Minnesota are the more important corn sections. This

distribution is probably due to the cultivable character of the fertile soil, the spring and summer distribution of rain, the long hours of sunshine, the high summer temperatures, and the development of the live stock industries. Corn has been grown (1910) in all but two counties of the State but it remains to be demonstrated how far north it will be a profitable crop. With the abandonment of the single crop system of wheat production and the adoption of diversified agriculture the production of hay and forage has extended over the entire agricultural area.

Animal Industries

With the diversification of agriculture has come development of the animal industries. The more important sections as shown by Figure 4 are southeastern and southwestern Minnesota. Horses and mules are the most important measured by value (Figure 1) and their distribution bears a close relation to the number of farms, the amount of improved land, and the oats- and corn-growing sections. Cattle for beef are being produced especially in the southwestern and extreme southeastern districts and for dairy purposes in the south central region and about the large cities (See article on dairy industry). Swine production is intimately associated with the dairy industry as they are raised on skim milk and fattened on corn and barley, corn being the more important food. The dry, high and well drained grass lands of the southwestern and southeastern districts are the more important sheep areas although sheep are distributed throughout the State.

Conclusion.—An attempt has been made in this brief summary to indicate the general distribution of agriculture in the State, the classes of agricultural products, some of the leading crops, the live stock industry, some of the factors influencing the distribution of agriculture, the change in the character of agriculture, and the most probable lines of future development. A thorough discussion of the subject has not been attempted. Every school in the State should secure a copy of "Early Economic Conditions and the Development of Agriculture in Minnesota" by E. V. Robinson, published by the University of Minnesota.

MINNESOTA

MINNESOTA STATISTICS

Area of state (Census 1910)	51,749,120 acres
Number of acres devoted to agriculture (Census 1910)	27,675,823 acres
Number of acres undeveloped (Census 1910)	24,073,297 acres
Vacant government homestead lands open for entry	1,500,000 acres
Approximate amount of state lands unsold	2,800,000 acres
Number of farms in state (Census 1910)	155,759
Average size of farms (Census 1910)	177 acres
Value of farms and buildings (Census 1910)	$1,259,510,000
Average value per acre of farms and buildings (Census 1910)	$46
Value of live stock (Census 1910)	$161,527,793
Increase in land Values, 1900 to 1910, $16 an acre	77%

NOTES ON THE GEOGRAPHY OF THE RED RIVER VALLEY

By Stephen S. Visher, Ph. D.
State Normal School, Moorhead, Minnesota

MINNESOTA'S most famous three possessions perhaps are the stupendous open-pit iron mines of the Mesabi Range; the enormous flour mills of Minneapolis; and the Red River Valley. The Red River Valley has been prominent for more than forty years. Its gigantic wheat harvests have contributed much towards making Minneapolis the greatest flour-milling city in the world; it has during the three decades preceding the last yielded perhaps more flax seed, as well as more wheat, than any other like area in the world; and its "bonanza" farms have been almost the type illustration of extensive farming operations.

Lake Agassiz and Its Effects

The Red River Valley is a lake plain rather than a river valley. It is part of the bed of glacial Lake Agassiz. This famous lake, when largest, extended nearly 700 miles north from Big Stone Lake, and embraced an area about one fifth larger than the combined areas of the present five Great Lakes. The existence of this vast lake is proven by the materials laid down on its bottom and by features produced along its margin. At some places, the waves cut low cliffs and terraces; along scores of miles of its shore they heaped up loose materials into beach ridges, parts of which subsequently were piled up by the wind into dunes. Deltas were formed where streams entered the lake.

Lake Agassiz came into existence when the glacier obstructed the normal drainage towards the north. The water rose in the basin until it overflowed to the south. When the melting of the glacier opened an outlet to the north lower than that through Big Stone Lake and the Minnesota River, the lake level fell from something like 1050 feet above sea-level to approximately 970 feet. With the disappearance of the glacier, the lake nearly disappeared. Lakes Winnipeg, Manitoba, Lake of the Woods, and several smaller ones may be looked upon as remnants for they occupy the deepest depressions in the old basin.

Lake Agassiz influenced in several ways the region it occupied. The Red River Valley owes to it the lacustrine silt, the upper few inches of which have weathered into very fertile soil. Much of the sediment brought into the lake was well sorted. In some deltas there are commercially valuable deposits of gravel and sand; from the one near Muskoda, about 18 miles east of Moorhead, tens of thousands of carloads have been taken. Although the margin of the lake plain is sandy in many places, little but fine material was carried far from shore; hence nearly all the more central part of the ancient lake is covered now by material very fine in texture, so fine, indeed, as to form, when water-soaked, an exceptionally sticky mud, locally called gumbo.

The flatness of most of the Red River Valley is remarkable. Professor

Davis states that the floor of Lake Agassiz is perhaps the largest almost flat area of agricultural land in the world. This flatness is in part due to the deposits which accumulated smoothly on the bottom of the ancient lake. The fewness and youth of the stream-valleys of this area have made the Fargo Quadrangle of the United States Topographic Atlas a favorite one for the study of the youthful stage of erosion. The briefness of the interval, only a few thousand years, which has elapsed since Lake Agassiz disappeared, is partly responsible for the character of the stream valleys. The thinness of the soil layer doubtless is another result of the same fact.

Some Results of the Flatness of the Area

The evenness of the surface and the general absence of bowlders and of trees or large shrubs are favorable to the use of labor-saving farm machinery. Traction plows, which are much used, and other machinery, made more easy the development of vast or bonanza farms. The topography favors road and railroad construction and use. The accessibility of the gravel deposits of some of the ancient deltas favored the gravelling of the railroads and roads, but such improvement of the roads has been delayed because for more than half the year dirt roads are fairly satisfactory. This is especially true during the several months when they are continuously frozen.

The levelness of the surface, the paucity of valleys, and the silty nature of the materials, combine to favor the soaking-in of moisture and to hinder its run-off after rains or melting. Since evaporation is relatively slow, a response to the general coolness of the climate, and as the run-off is slight, the average rainfall, somewhat less than 25 inches, is abundantly sufficient for the crops grown. Indeed, in unusually rainy years some areas, especially those relatively distant from stream-valleys, need artificial drainage.

The levelness of the area, its low elevation above the sea, in most places less than 900 feet, and its position near the center of the continent, combine to make the rate at which this area is lowered by running water exceptionally slow. It has been authentically estimated that the average rate of lowering of surface for the United States is about one inch in 760 years, while in the Red River Valley, 3900 years are required.

Climatic Influences

The climate as well as the soil, of the Red River Valley is suited to the growth of spring wheat, oats, barley, potatoes, rye and flax, the chief crops grown. In spite of the high latitude, much of the valley has a latitude of about 48°, and the low average temperature, approximately 38° F., these valuable crops are ripened during the short but almost tropically hot summer season of long days and short nights. The average July temperature is almost that of equatorial regions (70° F.). The fact that most of the precipitation falls during the growing season, when it is needed, is noteworthy. The shortness of the growing season is unfavorable to the production of corn or of fruits, but suitable varieties of these are being grown farther and farther

north, and corn already is important in the southern half of the valley. The long cold season discourages stock-raising, also, but it is conducive to social activities, reading and education.

Historical Geography

As the Red River Valley is not a part of the Mississippi drainage system, it was not included in the Louisiana Purchase, and did not become American territory until the Treaty of 1819 with Great Britain. Settlement had begun, however, near the present Canadian boundary, shortly after the beginning of the century, (1811). Steam-boats were run occasionally far up the river, but communication with the outside world was unsatisfactory until the coming of the railroads, and hence development was slow. For many years the chief mode of transportation between the settlements in the lower Red River Valley and the East, (Ft. Snelling, (1820-38), St. Paul, and later St. Cloud), was by means of picturesque but very cumbersome "Red River Carts." These crude, wooden, solid-wheeled vehicles were drawn by oxen.

With the coming of railroads, in the early 1870's, the development of the valley was rapid. By 1880, it was far more densely settled than most frontier regions. Upon its fertile plow-inviting soils, wheat crops often were raised, which yielded enormous profits until the price of wheat was forced down, by greatly increased production, from nearly or quite $1.20 per bushel to little more than half that price. This great increase in production was due not alone to the development of the Red River Valley; it was contributed to by many areas, in other parts of the world, where recently perfected labor-saving machinery, including discs, reapers and steam threshers, and railroads were also being used extensively. The ease with which profitable yields of wheat were produced in the Red River Valley permitted it to continue to be a great wheat-raising area when regions less favored geographically were forced by the lower price of wheat largely to abandon wheat-raising.

The one-crop method of farming, long in vogue in the Red River Valley, is being abandoned under pressure of increased value of the land, (an inevitable result of increased demands for land by the augmented population), of greater realization that diversification pays, and, in some sections, by the decreased yields following many years of careless wheat-culture. Other grains, especially oats, barley, and rye, were first extensively grown. Corn, in the southern sections, and potatoes more widely, have had greatly increased importance of recent years, chiefly because land which has been so tilled, yields the next year often nearly twice the average crop of wheat. The corn is mostly used as fodder for the rapidly growing herds. Many silos have been built lately. Potatoes are produced almost exclusively with the help of much labor-saving machinery. It is said that they may be raised profitably in rotation with wheat when the price is as low as 25c per bushel. When the price is two or even three times that great, as it sometimes is, the profits are large.

Possible Future Developments

It is likely that in the future, development in the Red River Valley will

continue along lines already followed; diversification of activities will proceed apace. The large farms will be cut up; live stock will be reared more generally; rotation of crops will be carried on more and more commonly; a number of crops such as alfalfa, root-crops, and vegetables not yet of importance, will become important; tillage will be increasingly thorough, and areas requiring it will be drained. Manufacturing is increasing rapidly in the cities of the Valley. It is likely to increase until a large share of the local demands for certain commodities will be supplied by local production. The production of such articles as flour, preserved vegetables and meats for which the raw materials are, or may well be, produced locally, and of various articles for which the transportation charges are much higher for the manufactured article than for the partly fabricated or raw materials, is to be expected. It is likely that many local manufacturing plants will be especially active during the long cold season, when out-door work is discouraged and when labor is cheapest.

Thus the Red River Valley is likely to lose some of the characteristics for which it has been famous. However, for geographic reasons, it is likely to continue to be an important wheat-growing region and an area in which farming on a large scale with the help of traction-engines and other labor-saving machinery is common.

MINNESOTA

SOIL MAPS OF MINNESOTA

By F. J. Alway

Chief of Division of Soils, Minnesota Agricultural Experiment Station

SEVERAL so-called soil maps of the whole state of Minnesota are on the market, but these either show so little detail or are so incorrect as to make them quite valueless. The only reliable maps are those published by the State Geological Survey and by the Bureau of Soils of the U. S. Department of Agriculture. A map of the northwest quarter of the state, on the scale of eight miles to the inch, has recently been published by the former, and five counties and parts of three others have been surveyed by the latter.

The map of the northwestern quarter, together with the accompanying report (Bulletin No. 12 of the Minnesota Geological Survey) may be obtained by remitting 25c to the Librarian of the University of Minnesota, Minneapolis.

A similar report with a map on the same scale for the northeastern quarter of the state is now in course of preparation. These two maps, which are based upon the drift survey of the state by Mr. Frank Leverett of the U. S. Geological Survey, show the general character of the soils of the different counties, but do not indicate the nature of the soil on the individual sections. The scale used is so small as to cause a quarter-section to appear on the map as a mere dot. As the report already published includes chapters on the climate, topography and glacial features of the whole state it will be of in-

terest and value to teachers in all parts of Minnesota, but especially to those in the surveyed counties: Becker, Beltrami, Clay, Clearwater, Hubbard, Kittson, Mahnomen, Marshall, Norman, Polk, Pennington, Red Lake and Roseau, and the adjacent parts of Cass, Crow Wing, Koochiching, Ottertail, Wadena and Wilkins.

The maps prepared by the Bureau of Soils may be secured by writing your member in Congress. Those already published include the following counties or parts of counties: Blue Earth, Goodhue and Rice; Carlton (in part) Crookston Area (southwest part of Polk) and Marshall Area (central part of Lyon). Pennington and Ramsey counties have been surveyed but the reports are not yet published. On these a scale of one mile to the inch is used which is sufficient to show on individual quarter sections the various soil types when these occur in areas of less than 10 acres.

No soil survey work is being conducted in the state at the present time. Beginning with 1915, the U. S. Department of Agriculture discontinued soil survey work in all states which do not contribute to the expense of the work. A bill introduced in the last Minnesota legislature providing an appropriation for soil survey work failed to pass. It is hoped that the next legislature will make an appropriation so as to permit of cooperation with the U. S. Bureau of Soils in the continuation of the detailed survey of individual counties.

MINNESOTA

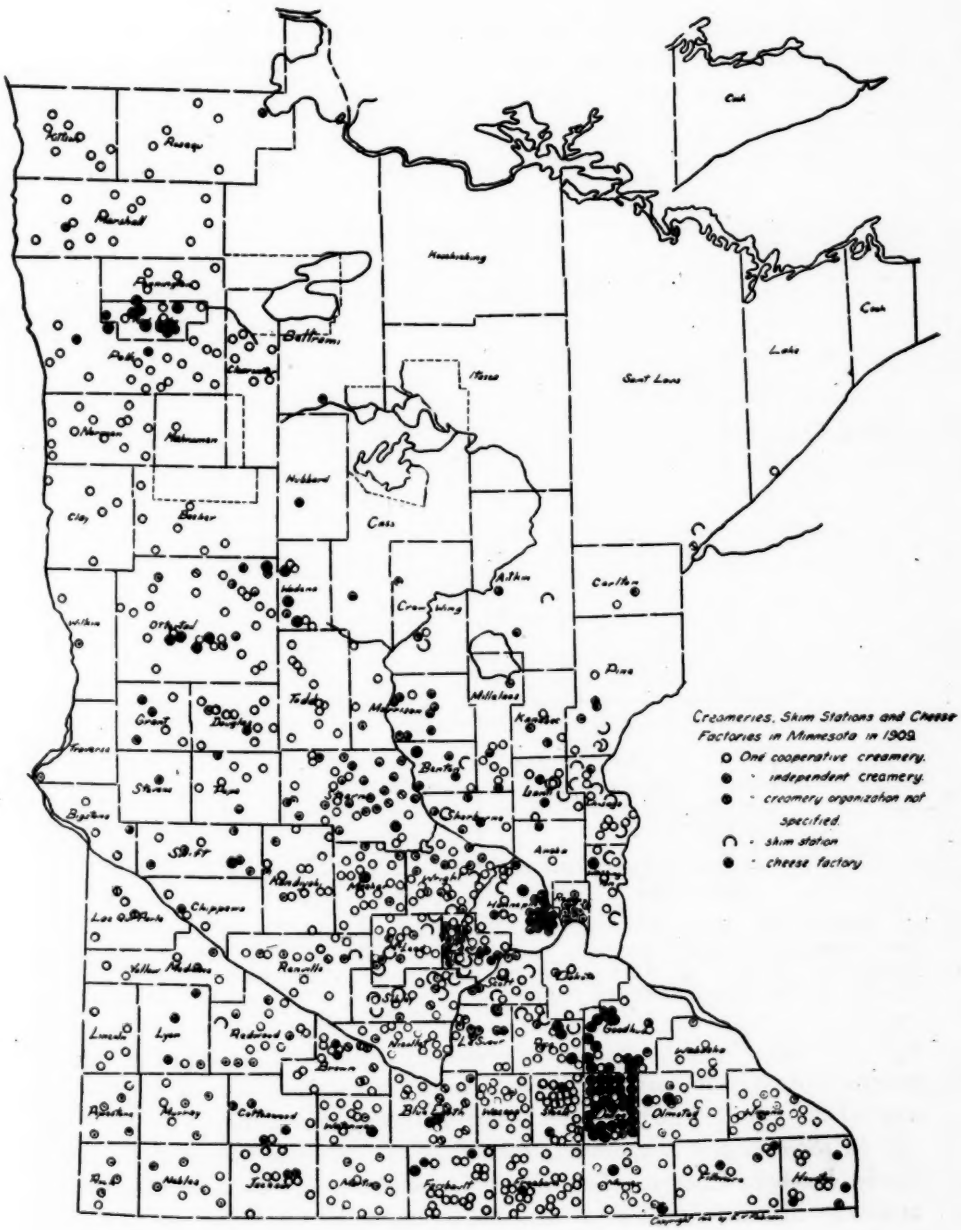
DAIRYING IN MINNESOTA

By R. M. Washburn

University of Minnesota

IN the matter of production of butter and cheese, Minnesota ranks third in the United States, following Wisconsin and New York. Every state may be said to be possessed of certain advantages for certain crops; and the production of wheat, oats, and flax were the crops which the fertile soil, abundant rain-fall, and comparatively level land of Minnesota encouraged.

The fertile, rolling fields of southern Minnesota were settled in the late 40's and the 50's, and wheat at once became the chief and almost only crop raised. So great was the production of this single crop that at one time the little city of Red Wing was said to be the largest primary wheat market of the world. The constant draught upon the soil, however, began to show its effects as early as 1870, and became pronounced by 1890, even though new fields had been brought under the plow. The central and western portions of the state were settled at a little later period but followed largely the lead of the farmers farther south. The immense quantities of small grains produced soon began to tell upon the fertility to such an extent as to cause some alarm. It was evident that a more rational system of farming was necessary. At this time, about 1890, by far the majority of the farms were mortgaged heavily.

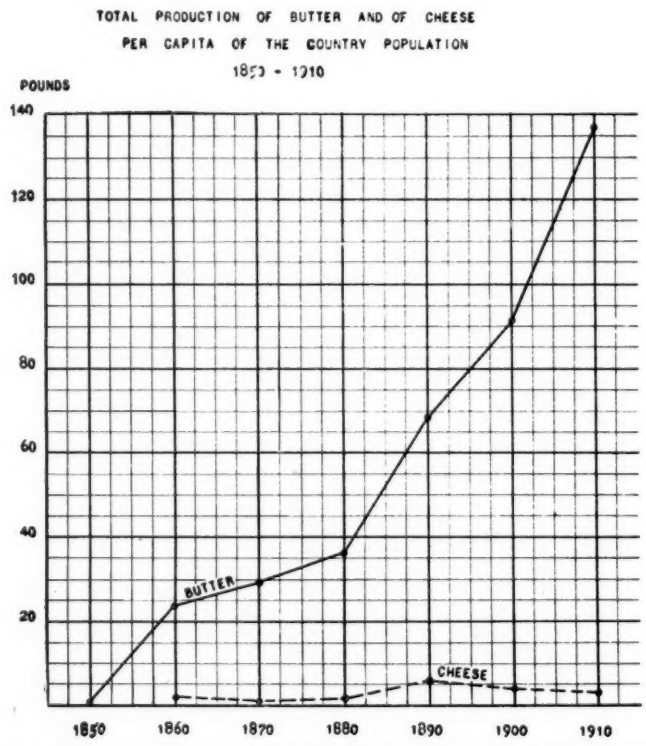


Distribution and organization of creameries, skim stations, and cheese factories in Minnesota in 1909. (From Robinson's "Economic History of Agriculture in Minnesota." University of Minnesota Studies in the Social Sciences, Number 3.)

Then, to make matters yet worse, the chinch bug appeared with its devastating attacks.

The Rise of the Animal Industries

It was at this juncture that interest in live stock, especially cows and hogs, became keen. The cattle then kept were of a mediocre beef variety and yielded little better than 125 pounds of butter per year, even when handled and milked with reasonable care. Butter was made at home to some extent



Butter and cheese per capita production of country population, including both farm and factory product, in Minnesota, 1850-1910. (From Robinson's "Economic History of Agriculture in Minnesota." University of Minnesota Studies in the Social Sciences, Number 3.)

but this was of indifferent grade, exceedingly un-uniform in character and commanding very low price. A few creameries had been started but these were of the so called gathered-cream sort and made poor butter.

In 1890 the first co-operative creamery of the state was started at Clark's Grove, Freeborn County. The form of organization of this association was unique at that time in dairy or agricultural matters. First, the cost of construction of the plant was paid from a sinking fund made up by with-holding a fraction of a cent per pound of butter from each and every patron delivering milk to the plant, thus the cost was pro-rated against the farmers according to benefit received. Second, the distribution of all surplus was made pro-rata

according to patronage, thus encouraging production. Third, each man owning stock in the company had but one vote regardless of the number of shares held. This was done to discourage any individual endeavoring to acquire control of the business. These three principles have stood as the foundation upon which 625 co-operative creameries of the state have been builded.

Once the practicability of the co-operative creamery was demonstrated, growth in dairying was rapid. From the start the growth of the industry has been natural, and comparatively few of the ill-advised "promoted" creameries have been built. Both the growth of the co-operative creameries on a sound co-operative basis and the check of the over-zealous creamery promoter is due in a large measure to the influence of the State Dairy School which was organized in 1892 and which has since given instruction to more than 2000 students.

The majority of the creameries are located in the southern portion of the state, though prosperous plants are now in operation throughout the western prairie counties as well as in the more northern wooded sections. Ottertail County leads the state in total number of creameries, there being thirty within its borders, with more than $900,000 paid out annually to its farmers. The little village of Milaca in Mille Lacs County boasts of having the largest co-operative creamery in the state. This association pays out to the surrounding producers more than $300,000 annually.

High Quality of the Butter

This state is particularly proud of its record in the matter of winning first prizes at national and inter-national contests in creamery butter. The following is a list to date of the prizes won in open competition with the butter makers of the United States and Canada:

Year	*Convention held*	*Prize won*
1899	Topeka, Kansas, N. C. B. A.,	$100, Silk Banner.
1901	St. Paul, Minn., N. C. B. A.,	$100, Silk Banner.
1902	Milwaukee, Wis., N. C. B. A.,	$100, Silk Banner.
1904	St. Louis, Mo., World's Fair,	grand prize diploma, awarded state or country with largest percentage of scores of 95 or better.
1906	Chicago, Ill., N. C. B. A.,	$100, Silk Banner.
1908	St. Paul, Minn., N. C. B. A.,	$100, Silk Banner.
1909	Milwaukee, Wis., N. C. B. A.,	$100, Silk Banner; 96.53, average of ten highest entries from state; 95.86, Wisconsin, next highest.
1910	Chicago, Ill., N. C. B. A.,	$100, Silk Banner; 95.86 average of ten highest entries from state; 95.69, Wisconsin, next highest.

1911—Chicago, Ill., N. C. B. A., $100, Silk Banner; 96.53, average of ten highest entries from state; 95.86, Wisconsin next highest.

1911—Milwaukee, Wis., International Dairy Show, silver loving cup; highest average of twenty highest entries.

1912—Milwaukee, Wis., International Dairy Show, silver loving cup; highest average of 15 per cent of creameries of state.

1913—Chicago, Ill., N. C. B. A., $100, Silk Banner; 96.248, average of ten highest entries from state; 95.68, Iowa, next highest.

1914—No contest held.

1915—Mason City, Iowa, N. C. B. A., $100, Silk Banner. Score 95.55; Iowa next highest, 94.92.

It should further be explained that there have been in all only fifteen contests of a national or inter-national nature, and that the grand championship prize has come to Minnesota in thirteen of them. And, as a matter of fact, it was Minnesota-trained men who carried off the honors for another state on one of the two occasions when Minnesota lost.

The 1913 legislature provided that under certain conditions creameries might stamp their butter with the name "Minnesota." There are now twelve "state brand" creameries which have fulfilled the 13 rigid requirements for A-1 Grade, and the 11 requirements for B Grade.

The likelihood of our continuing to win the national grand championship prize increases with the number of creameries qualifying under the "state brand."

Cheese Factories and Condensaries

A cheese factory to be profitable requires only about one-fifth as many cows and one-fifth as much capital as a creamery, and for this reason cheese factories were built very largely during the earlier days of dairy development. For various reasons, however, chief among which was the cost of delivering the large quantities of sweet milk to the factory daily for cheese making, the majority of these plants have been converted into butter-making establishments, until there are now only seventy-two cheese factories in the state. These, however, are well established, doing good business and in every way demonstrating their right to be. The number is slowly increasing.

There had never been a condensed milk factory in the state until quite recently and there are but 4 at the present time. There are likewise two plants equipped for the making of dry milk or milk flour.

The Spread of Dairying and its Value to the State

The northern portion of the state, once so heavily wooded and later thought to be of little value, is now developing most rapidly into prosperous agricultural communities, and this is very largely due to the use of the dairy

cow and the manufacture of her product in the co-operative creameries. The comparatively cheap land of the northern counties will produce nearly, if not quite as much profit when pastured to cows as will the farms of the southern counties valued at three to six times as much per acre.

The short-horn was the first distinctive breed of cattle to gain prominence in the state and there are still a larger number of grades of this breed than any other. The distinctive dairy breeds are, however, increasing more rapidly in number than are the beef breeds. The Holstein-Friesian, the Guernsey, the Jersey, and the Ayershire are increasing in number most rapidly in the order named, and with their increase in number a marked improvement is noticed in the average yield of the cows of the state, the present average being about 175 pounds of butter per cow per year.

The creamery butter and factory-made cheese in Minnesota amounts to more than $38,000,000 per year, a sum nearly one-third greater than the total out-put of gold from Mexico under normal conditions, and nearly one-half as great as the total gold out-put of the United States including Alaska, while the total value of dairy products in Minnesota is about $96,000,000.00 annually. The production of butter may be said to be a perpetual gold mine, since the ingredients of which butter is made are of the cheapest on the farm. The manufacture and sale of butter feeds humanity without impoverishing the farm from which it was derived and is in a true sense a creative industry and one worthy of even more encouragement than it has received in the past.

MINNESOTA

FRUIT GROWING IN MINNESOTA

By Le Roy Cady
University of Minnesota

THE varied soil and climatic conditions in Minnesota makes possible the growing of most of the small fruits, such as strawberries, raspberries, currants, gooseberries, blackberries and many varieties of apples and plums generally throughout the state. Cherries are grown to advantage only in the southeastern part of the state, and even here are not always a paying crop. Apples are grown in large quantities in the southern half of the state and may be grown in quantities for home use in almost any part of the state if the right sorts are selected.

Apples.—The principal fruit districts at present are the district about Lake Minnetonka and the southeast quarter of the state. These sections produce as nice Wealthy, Patten, and Northwestern Greening as can be raised in the United States. Apples seem to do best on rolling land, often land along the lakes and rivers that cannot be used to advantage for other crops. An open clay subsoil and a northeast slope gives the best apples.

Plums of native origin do well throughout the state generally. The Japanese and European sorts may be grown in favored places, such as along

the river in eastern Minnesota and about the larger lakes, such as Minnetonka. The lakes and rivers of the state have a great influence on the fruit growing industry, since they tend to protect fruit and flowers from frosts at certain seasons to some extent. Plums are found wild in abundance in the timber sections of the state.

Berries.—Strawberries and raspberries among the small fruits may be grown anywhere in the state for home use, and in most places can be grown for market to advantage if there is a market near enough to take the fruit. Small fruits must be marketed near home for they will not stand shipment over long distances without the extra expense of icing and special care. So those expecting to market small fruits should live near a town having good shipping facilities and that is not too far from a good market.

The best strawberry and raspberry sections seem to be Lake Minnetonka, and about the large lakes of north central and southeastern Minnesota. Blackberries and dewberries may be grown under about the same conditions as raspberries, although they are a little more tender and more particular as to soil. Throughout Minnesota it seems the safest and best plan to lay down the raspberries and blackberries, covering with earth to prevent winter injury. Strawberries are usually protected by covering with a few inches of straw. This helps to prevent freezing and thawing in winter and helps to hold the foliage over to better advantage.

Many varieties of strawberries are grown, but among the best are Senator Dunlap, Bederwood, and Warfield. The autumn-bearing sorts are coming into notice now. They require about the same treatment as June fruiting sorts, except that all buds should be kept off up to about the first of July, when fruit in abundance may be expected from August until cold weather.

Currants and gooseberries can be grown in all parts of the state. They require good, rich, sandy loam and thorough cultivation for best results. Locations near large towns or where there are good shipping facilities are best for commercial currant-growing. As a home fruit they should be in every garden because of their ease of growing and fruit yields.

Grapes can be raised to advantage only about the larger bodies of water, such as Lake Minnetonka. A sunny, warm, well-drained location should be chosen. The south side of a hill is best. Many thousands of pounds of grapes were formerly grown in the state, but the cost of winter covering and pruning does not permit of competition with grapes from more favored sections of the United States.

Many *wild fruits* are found in the state. *Cranberries* are abundant in many of the marshes in the northeastern section of the state and it is quite likely that in time companies will be formed to raise them on a commercial scale. Other forms of wild fruit are highbush cranberries, black haw, wild cherries, plums, raspberries and blackberries. All are grown in the timbered sections of the state. Thousands of acres of the *blueberry* are found in the

northern part of the state. These are gathered in large quantities both by the settlers and Indians, and marketed.

While the *nut industry* of the state is not large, it has some importance in the southeastern section of the state, where black walnut and hickory are quite common. The butternut is grown in the timber sections up to the vicinity of Mille Lacs lake.

Nurseries.—The demand for planting stock of fruits and ornamentals has caused the establishment of about one hundred nurseries, located near the centers of population in the state. These vary in size from a part of an acre to two or three hundred acres of actual nursery stock. The largest nurseries are located about Minneapolis, Lake City and Owatonna.

Fruit Associations.—Much of the fruit is marketed through associations located in the fruit-growing centers. These associations handle, in good seasons, from a few hundred to fifty or sixty thousand dollars worth of fruit for their members, at a cost of about five per cent.

The Flower Industry

The growing of flowers and ornamental plants commercially has increased greatly the last few years. Every town of any size either has a small greenhouse or looks to some nearby establishment for its supply of cut flowers. In the large cities there is a considerable sum of money invested in greenhouses and stock. Large quantities of chrysanthemums, carnations, roses, violets, and potted plants are grown for market. Thousands of bedding stock is grown and sold in the spring. The largest flower establishments are, of course, located in St. Paul and Minneapolis. There are also important establishments at Mankato, Owatonna, Albert Lea, and Austin.

Besides the greenhouse trade, there are thousands of dollars worth of flowering perennial plants sold from the nurseries, such as paeonies, iris, phlox, etc. Paeonies are grown for their cut flowers near the large cities. Dahlias and gladioli furnish large quantities of cut flowers to the flower markets each fall, sometimes, in fact, seriously competing with greenhouse-grown flowers. Asters and some other annuals are grown for early summer use both in the greenhouse and the field.

The following tables will give an idea of the quantity and value of the different fruits and vegetables in Minnesota according to the latest census, that of 1909:

	Acreage 1909	Bushels 1909	Value 1909
Potatoes	223,692	26,802,948	$7,686,339
Onions	1,099		182,069
Cabbage	2,315		128,430
Dry Beans	4,697		124,996
Sweet Corn	2,829		62,387
Cucumbers	1,190		59,512

Tomatoes	449		52,631
Melons	453		41,913
	Acreage 1909	Production in Quarts	Value
Strawberries	1,872	2,730,099	$268,772
Raspberries	1,388	1,340,469	178,689
Currants		182,825	19,783
Blackberries		139,741	17,696
Gooseberries		60,661	6,412
Cranberries		22,112	1,981
Nurseries	3,854		$863,014
Flowers under glass			603,935

MINNESOTA

GEOGRAPHIC INFLUENCES IN THE EXPLORATION AND EARLY DEVELOPMENT OF MINNESOTA

By C. J. Posey
University of Minnesota

SITUATED as Minnesota is at the geographic center of the continent it was natural that its settlement and development should come later than much of the country lying nearer the Atlantic seaboard. In the matter of its exploration, however, this region was pretty well known to the French nearly a century before the region west of the Appalachians was as well known to the English. Though there is lacking positive proof, yet it is possible that Radisson and Groseilliers were within the limits of this state in 1655, and very probably in 1659. But the first authentic record is that of the trip of the Sieur Duluth, in 1679, who, coming by the way of Lake Superior, went inland as far as Mille Lacs.[1]

That knowledge of Minnesota was obtained relatively so early was due in part to the topography and drainage of the state. Here no great topographic barrier obstructed the path of the voyageur; instead here is a glacial plain studded with many lakes and crossed by many streams, and as a result passage from one river system to another usually required only a short portage. Here, further, three great river systems of the continent, the Mississippi, the St. Lawrence, and the Nelson-Red, have their sources, and they afforded easy access from three different directions. It is significant that the first two authentic exploring expeditions within the present borders of the state entered by two of these waterways, Duluth by the St. Lawrence and Hennepin by the Mississippi, and that the leaders should actually have met in the vicinity of Mille Lacs in 1680. Later when it came to the matter of establishing posts and permanent settlements, we find that entrance was made by each of these three river systems. Aside from the soldiery the first white settlers came by way of the Red river,[2] but by 1850 the larger number of

1. Folwell: Minnesota. pp. 7-21.
2. Ibid: pp. 78, 79.

settlers had come in by way of the Mississippi. It was not until considerably after that date that the Lake Superior route had contributed more immigrants than that of the Red river. Had there been no major drainage lines connecting the state with the more densely populated regions to the east and south there is little doubt but that its development would have been somewhat delayed.

The impelling causes that brought the French so far west so early were several. The principal ones were the desire to do missionary work among the Indians, to find a water route to the Pacific, the innate love of adventure, the desire to achieve fame through some great discovery, and to trade with the Indians, getting from them the furs at that time much in demand in the European markets. It was for furs that Radisson and Grosseilliers first came into this region and on their return from their second trip they are said to have reached Montreal in 1660 "in sixty canoes loaded with furs worth $40,000." Probably only a small portion of these were obtained within the confines of Minnesota. Duluth was sent out by a company of Canadian merchants who desired to establish trade about and beyond the head of Lake Superior, and from that time until approximately 1850 furs were the leading product of what is now Minnesota. It should be added that the fur industry was the leading industry of Minnesota for a much longer time than any other single industry.

In considering the importance of the part played by the furs in bringing the French and later the English into this region, it should be remembered that after all the presence of the animals bearing the high quality of furs found here is a reaction to the climatic conditions that obtain. With an abundance of lakes, with large forest and large prairie tracts, and with long, cold winters this region furnished an ideal habitat for fur bearing animals. Thus did the climate of this mid-continent area play a part in bringing about its early exploration.

In still other ways the climate has played an important part in the development of this state, in some respects the influence being direct and of an unfavorable character. For several months of the year the streams are unnavigable because of the ice. In the early days of St. Paul navigation on the Mississippi was "not to be relied on after the first week in November; and steamboats arrived in the spring about the 10th or 12th of April."[3] Thus before the coming of the telegraph and railroad there were five months when the village had little communication with the outside world. The following taken from the Minnesota Pioneer of April 28, 1849, is typical of those times: "During five months the communication between this part of the country and our brethren in the United States has been difficult and unfrequent. A mail now and then from Prairie du Chien, brought upon the ice in a 'train' drawn sometimes by dogs, containing news so old that the good people in the country

3. Sibley: Description of Minnesota. Minn. Hist. Soc. Coll. Vol. 1, pp. 40, 41.

below had forgotten all about it.—When the milder weather commenced, and the ice became unsafe, we were completely shut out from all communication for several weeks." To the extent that these conditions were known to the people to the states to the south and east they acted as a deterrent to prospective immigrants. Besides little in the way of building operations was done here during the winter months.

Preceding 1850 the impression was abroad in some sections of the country that the frost free season here was too short for the maturing of most agricultural crops. In the early issues of the Minnesota Pioneer statements to correct this idea occur frequently. But it was not long until it was abundantly proven that crops would mature here as surely as farther south.

The falls and rapids of the streams have played an important part in the development of the state since they determined the places of portages, in some instances the head of navigation, and later, because of the water power, the location of urban centers. But two examples need be mentioned. A short distance below the falls of the St. Croix the first settlement of Americans was made within the state in 1839, and soon there grew up settlements along this river which centered about Stillwater and which in 1849 were outnumbered only by those about St. Paul. The Falls of St. Anthony determined the sites of both St. Paul and Minneapolis, the former at the point to which boats could conveniently ascend, and the latter at the power site itself. It has recently been shown that within another mile of recession[4] the Falls of St. Anthony would have disappeared, and had this been accomplished before the white man appeared upon the scene it is quite likely that the metropolis of the state would not be where it now is. That the early settlers appreciated the value of the power sites is shown by the fact that within the shortest possible time after the tidings of the ratification of the Indian treaty ceding the triangular strip of land between the Mississippi and the St. Croix to the Government claims abutting the Falls of St. Anthony on the east bank and those of the St. Croix were staked out.[5]

The original forests of Minnesota influenced its early development both unfavorably and favorably, but the latter influence has been by far the greater. The principal unfavorable influence was the difficulty offered to the laying out of the early trails and roads. Usually the trails kept to the prairie stretches as much as possible for the traders had not the time nor were they disposed to expend the means necessary to construct roads through a wooded country. This often resulted in the sacrifice of directness of route. Of the three routes from St. Paul to the Pembina settlement, two, the southern and the middle, clung to the open prairie practically all the way.[6]

By far the largest influence of the forests has been in the lumber they have yielded. The first lumber mill in Minnesota was erected at the Falls

4. Soper: The buried rock surface and preglacial river valleys of Minneapolis and vicinity Jour. Geol. Vol. 23, p. 446.
5. Folwell: Minnesota. pp. 80-81.

of St. Anthony in 1821 for the purpose of sawing lumber for Fort Snelling. The lumber industry did not begin until 1838 for previous to that time private ownership of land within the state could not be acquired. By 1850 the lumber industry rivalled the fur trade in importance and very soon surpassed it.[7]

When it came to occupying the land the settlers preferred the prairie tracts, for by the time settlement began here it was known that absence of timber did not necessarily mean poor soil. At first, however, the settlers kept close to the timber so that the fuel needed for the rigorous winter could be secured easily. The fertile soils of the state did not begin to assume primary importance in its development until toward the close of the 1850's. By 1860 agriculture had forged to the front among the state's industries where it has since remained. In the decade 1850-1860, when the agricultural lands were being rapidly occupied, Minnesota had her greatest percentage increase of population, 2,730%, a percentage increase unequaled by any of the states in any decade.

It is an interesting fact that one of the natural resources Minnesota was early believed to possess should actually be the last one to assume great importance. During the French period rich metal deposits were believed to exist in this region, but in what section they were to be found was not so clear. So strong was this belief that Le Sueur came into the country in 1700 in search of copper. He ascended the Minnesota to the Blue Earth, and a few miles above its mouth discovered a deposit which he supposed to be copper. He loaded his canoes with this "blue earth" and about 4,000 pounds of the clay eventually found its way to France by way of New Orleans.[8] It was not until 1884 that the production of metals began in Minnesota. And it is to this industry that the "Range towns" and Duluth owe their recent rapid growth.

6. Pope: Exploration of the T'y of Minn. Ex. Doc. 42, 31st Cong. 1st Sess. pp. 8, 9, 16, 19.
7. Robinson: Economic History of Agriculture in Minnesota. Univ. of Minn. Studies in Social Sciences, No. 3, p. 39.
8. Neill: Minn. Hist. Soc. Coll. Vol. 1, pp. 33-34.

MINNESOTA

ESTIMATED AMOUNT OF TIMBER STANDING IN THE STATE IN 1911

Species	M. B. F.	Species	M. B. F.
Ash	144,442	Oak	96,645
Balm of Gilead	1,189,000	Jack pine	3,141,850
Basswood	495,380	Norway	4,625,750
Balsam	370,300	White pine	3,818,000
Birch	152,983	Poplar	4,044,000
Cedar	634,000	Spruce	2,292,800
Elm	92,611	Tamarack	1,685,450
Maple	163,977		

M. B. F. signifies 1000's of board feet.

MANUFACTURES IN MINNESOTA

By E. Dana Durand

University of Minnesota

MINNESOTA is still primarily an agricultural state. It is true that at the last decennial census the value of manufactured products in the state, $409,420,000,* greatly exceeded the net value of agricultural products. Assuming that approximately one-half of the value of animal products is represented by the value of crop products fed to animals, the total value of Minnesota's agricultural output in 1909 was about $240,000,000. But the true measure of the importance of manufacturing industry is the value which the manufacturing process adds to raw materials, the materials being chiefly the products of agriculture or of mining. The value added to materials by Minnesota factories in 1909 was about $128,000,000, somewhat more than half the net value of agricultural products. In the United States as a whole the value created by manufacturing industry exceeds by about one-fourth the value of agricultural products.

Character of Minnesota's Manufactures

A striking feature of manufacturing in Minnesota is the predominance of industries which add comparatively little to the value of raw materials. Of the gross value of manufactured products in Minnesota at the last census only 31 per cent represented the part created by manufacturing processes, while the corresponding proportion for the United States as a whole was 41 per cent. The great importance of the flour mills, the meat packing establishments, and the creameries of Minnesota largely accounts for the fact that the value of raw materials used by her manufacturing establishments is more than double the value which they add to those materials.

The State's Rank

Of the gross value of manufactures for the United States as a whole Minnesota produces one-fiftieth, a slightly smaller proportion than that which her population forms of the total population. Of the value added to materials by manufacturing processes, however, Minnesota contributes only 1.5 per cent, and of the number of wage earners in manufacturing industries she has only 1.3 per cent. Among the states Minnesota in 1909 ranked thirteenth in gross value of manufactures, thirteenth also in value added to materials by manufacturing processes, but only eighteenth in number of wage earners engaged in manufacturing industries. On the other hand, she ranked eleventh among the states in value of crops, with 3½ per cent of the total value for the United States.

As in the United States as a whole, manufacturing industry in Minnesota is increasing more rapidly than agricultural industry. This fact does not

*The results of the quinquennial Census of manufactures, taken in 1915, are not yet published.

appear from the statistics for value of output, because the unit prices of agricultural products have gone up so much more rapidly than those of manufactured products that the total value of the output of the former has, in the United States as a whole and likewise in Minnesota, increased at substantially the same rate as that of manufactured products. The number of persons engaged in manufacturing industry has, however, risen much faster than the number in agriculture, and if there were some way of totalling the physical quantities of output of diverse products, the increase in manufacturing industries would, beyond question, appear much the greater.

However, manufacturing industry in Minnesota is not growing more rapidly than in the United States as a whole. The gross value of the products of Minnesota factories increased 83 per cent between 1899 and 1909 and the value attributable to manufacturing processes 74 per cent. These percentages were substantially the same as those for the country as a whole. On the other hand, the number of wage earners in manufacturing plants in Minnesota increased 31 per cent, while the corresponding figure for the entire country was 40 per cent. More than half of the states showed greater percentages of increase in value of manufactures during the decade than Minnesota.

Nevertheless Minnesota ranks third among the states west of the Mississippi in manufactures. Only Missouri and California are more important in this respect.

The Principal Manufactures

The following table lists the leading industries of Minnesota in 1909 according to three different standards of measurement—the gross value of products, the value added by manufacture and the number of wage earners. There is very considerable difference in the ranking of industries in Minnesota according to these different standards. From most standpoints the ranking according to value added by manufacture or according to number of wage earners is more significant than that according to total value of products.

Rank of the leading industries of Minnesota, 1909

As measured by value of product	*As measured by value added by manufacture*	*As measured by number of wage earners*
Flour mills (34%)	Lumber mills (17%)	Lumber mills (24%)
Lumber mills (10%)	Flour mills (12%)	Railroad repair shops (10%)
Meat packing	Printing & publishing	Foundries & machine shops
Butter and cheese	Foundries & machine shops	Printing & publishing
Printing & publishing	Breweries	Flour mills
Foundries & machine shops	Railroad repair shops	Boot & shoe factories
Railroad repair shops	Meat packing	Men's clothing
Linseed oil mills	Bakeries	Meat packing
Breweries	Patent medicines, etc.	Marble & stone work
Boot & shoe factories	Boot & shoe factories	

Flour Milling.—As might be expected from her own great grain fields and her proximity to still greater grain fields further west, by far the most important industry in Minnesota as measured by value of products is that of flour milling. This alone accounts for more than one-third of the total value of output of her factories. Minnesota far outranks any other state in the flour milling industry. In 1909 she turned out nearly one-sixth of the total value of products of this industry in the United States. However, the great bulk of the value of flour and other products of the grain mills is represented by the grain itself, the value added by manufacturing processes constituting only about one-ninth of the total. Consequently the flour milling industry ranks below the lumber industry in value added by manufacturing processes, and ranks only fifth among the industries of the state in number of wage earners—this latter fact attesting strikingly to the highly automatic character of the machinery used in the great Minneapolis mills. Minnesota, however, is justly proud of the great flour mills which cluster around the falls of St. Anthony. Their product is famed for its quality throughout the country and the world. No other flour mills anywhere equal in size or in efficiency these great establishments.

The lumber industry still outranks all other manufacturing industries in Minnesota in the number of wage earners employed. This industry, as treated by the census, includes the cutting of timber as well as its manufacture into lumber and other products. As might be expected, however, from the rapid exhaustion of Minnesota's native forests of white pine and other woods, this industry is declining in absolute importance and still more in relative importance.

The meat packing and butter and cheese industries are naturally important in this great agricultural state.

In the manufacture of *linseed oil* Minnesota occupies a very important place, as a large proportion of the country's output of flax seed, which constitutes the raw material, is produced in Minnesota and the Dakotas. Nearly one-third of the linseed oil manufacture of the country is conducted in this state, although New York, curiously enough, ranks even higher.

The other leading manufacturing industries of Minnesota, unlike the five just mentioned, are neither dependent upon her agricultural products nor her forests. In fact, their importance cannot be attributed to any special natural resources within the state. They are such miscellaneous industries as naturally grow up in large cities.

Iron Manufactures, Present and Future

It is a striking fact that up till 1915 no important manufacturing industry developed in Minnesota as the result of the presence in the state of the most magnificent iron mines of the world. Minnesota produces five-eighths of the output of iron ore in the United States, but down to the present time practically none of that ore has been smelted or otherwise used in the state. It

has been shipped to Lake Erie or lower Lake Michigan ports for manufacture in their vicinity. Fortunately an immense iron and steel plant has just been built at Duluth and even now is commencing operations. The prospects are that the manufacture of the heavy forms of iron and steel will soon become one of the leading industries of the state and that the greater part of the demand for these products throughout the Northwest will be supplied from Minnesota plants. While the state is lacking in the coal necessary for the smelting and manufacture of iron and steel, it is obviously advantageous for ore vessels returning from the lower lakes to load with coal for Lake Superior ports. However, the lack of coal within the state of Minnesota does considerably hamper the development of manufacturing industries.

Manufacturing Cities

A large proportion of the manufacturing industry of Minnesota is confined to the three great cities, Minneapolis, St. Paul and Duluth. There are comparatively few states in which such a large proportion of the urban population is found in such a small number of individual cities. Winona, the next city to these three in size, has less than one-fourth of the population of Duluth and less than one-fifteenth that of Minneapolis. There are only four other cities exceeding 10,000 in population. The following table compares the principal data (in round numbers) regarding manufacturing industries for the three leading cities with those for the state as a whole.

Manufactures in Minnesota, 1909

	Wage earners		Value of Products		Value added by manufacture	
	Number	Per cent of total	Amount	Per cent of total	Amount	Per cent of total
Minnesota, total	84,800	100	$409,000,000	100	$128,000,000	100
Minneapolis	27,000	32	165,000,000	40	45,000,000	36
St. Paul	19,300	23	59,000,000	14	29,000,000	22
Duluth	6,100	7	17,200,000	4	8,300,000	7
All other places	32,400	38	168,000,000	41	45,000,000	36

This table shows that fully three-fifths of the manufacturing is carried on in the three leading cities. Minneapolis, the largest city, ranks first in respect to all three of the standards of comparison shown in the table, but its lead with respect to number of wage earners and value added by manufacture is far less marked than that with respect to total value of products, a fact attributable to the predominance of the flour milling industry in Minneapolis and the relatively small number of wage earners and relatively low value added by manufacture in that industry. It will be observed that, whereas for Minneapolis the value added by manufacture forms only a little more than one-fourth of the total value of products, for St. Paul and Duluth the

proportion is nearly one-half. It may be noted that the figures for St. Paul do not include the large meat packing plant in South St. Paul.

The value of the manufactured products of the other cities of more than 10,000 inhabitants in Minnesota in 1909 was as follows:

Winona, $11,200,000
Mankato, $3,700,000
Stillwater, $2,700,000
St. Cloud, $2,300,000
Virginia, $500,000

Minneapolis and St. Paul

There is very considerable difference between Minneapolis and St. Paul with respect to the rank of manufacturing industries. As measured by total value of products the leading industries in Minneapolis are in order: Flour mills, lumber mills, foundries and machine shops, printing and publishing, railroad repair shops, bakeries, and breweries. In St. Paul they are: Printing and publishing, foundries and machine shops, breweries, boot and shoe factories, railroad shops, fur goods factories, and butter and cheese factories. Not far from one-half of the total value of manufactured products in Minneapolis is represented by the output of the flour mills, but there is no such one predominating industry in St. Paul. Even in respect to value added by manufacture the flour milling industry ranks first in Minneapolis though with no very great lead over the lumber and printing industries. In respect to number of wage earners, however, the flour mills of Minneapolis rank below her lumber mills, foundries and railroad shops.

The manufacturing industries of St. Paul have of late been growing somewhat more rapidly than those of Minneapolis. This is in considerable measure attributable to the convenience for shipping afforded to manufacturing establishments by the Minnesota Transfer Railroad in the so called Midway district, which lies between the hearts of the two cities, but with the greater part of its area in St. Paul. An active movement is on foot for the creation within the city limits of Minneapolis of an industrial district offering similar facilities. There is a healthy rivalry between the two cities in efforts to build up their manufacturing interests.

As might be expected from the fact that it is a smaller and more rapidly growing city, the manufacturing industries of Duluth increased during the last census decade at a higher rate than those of St. Paul. The opening of the new steel plant at Duluth will probably cause its aggregate manufacturing business to increase still more rapidly during the present decade. The lumber industry has heretofore represented nearly one-third of the manufacturing of Duluth.

MINNESOTA CITIES: MINNEAPOLIS

By C. E. Huff
West High School, Minneapolis

History

MINNEAPOLIS, "City of the Falls,"* is the metropolis of the state and the gateway to the northwest.

Like many another city in this great new country of potential wealth, its history reads like a fairy tale. Less than seventy years ago the land where Minneapolis now stands was a broad stretch of level prairie interspersed with gently rolling hills and forest stretches, and inhabited by Indians. To be sure a saw mill was built on the present site of the Pillsbury-Washburn flour mill "A" as early as 1821, and a flour mill followed soon afterwards. But it was not until 1838 that the government gave permission to stake out claims for settlement. The first of these claims to be staked were adjacent to the falls and included all possible power sites, for even at that time the adventurous newcomers saw wonderful possibilities in the water power of the falls. From the first settlement to the present time the development of the city has been almost phenomenal, with an average increase in population of over five thousand people for every single year in its history. So it now has a population of about 350,000.

The reasons for this rapid growth are found largely in the geography of the region together with the fact that it is the commercial gateway to an agricultural empire larger than England, Germany, and France combined. The story of its development is the story of logging camps and lumber woods to the north, of log drives on rivers and of saw mills at the falls. It is the story too of wheat fields and of railroads and flour mills. And in her effort to provide materials for shelter for the ever increasing population of the expanding northwest, and to furnish bread for the millions in many parts of the earth, Minneapolis with St. Paul has become the great industrial and commercial center of the upper Mississippi.

Geographical Setting

The physical environment of Minneapolis has favored this development. From the heart of the big forests of white pine and other lumber producing trees, which formerly covered most of the northern part of the state, there flowed the Mississippi with many smaller tributaries. With the melting snows each spring these streams have borne hundreds of millions of feet of logs from the pineries to the mills at only a nominal cost to the lumberman. With the coming of railroads the wheat fields were brought to the very door of Minneapolis, for stretching away to the west are the nearly level prairies

*For a brief history of Minneapolis see Parsons, "The Story of Minneapolis." (Board of Education.)

which not only produce bounteous crops, but furnish easy grades for railroads which may be built at a minimum cost.

The Mississippi and other smaller rivers have been important in other ways in effecting the development of the city. Within the memory of many citizens still living in Minneapolis small steamboats carried freight and passengers not only up to St. Anthony Falls but to various points up river above the falls. In the same way the Minnesota and St. Croix were also of much value during the early period of development. Now that the railroads have come to carry the rapidly increasing volume of commodities, they find their easiest grades, even in this prairie country, along the valleys of the Mississippi and Minnesota rivers.

Not only have the falls, the forests, the fertile soils, the rivers and their valleys, and the level prairies encouraged the development of a city here, but as if to force us to the task, nature has laid down here untold quantities of the very best building materials. Blue limestone is all about, beneath only a few feet of glacial drift. In both the business and residence parts of the city are great quantities of water washed sands and gravels which are so valuable in modern building operations where Portland cement is used.

Another geographic factor has favored the development of the city. It is at the crossroads of the continent. With Duluth, Winnipeg and other cities to the north, and New Orleans and many other southern cities near the Gulf of Mexico, and in an almost direct line with our Atlantic and Pacific ports by way of the level Mohawk valley and shore of the Great Lakes, and westward over the Rockies by way of the lowest mountain passes, Minneapolis is at a point of vantage seldom surpassed by an inland city.

The Water Power

How important the Falls of St. Anthony and the rapids in the river have been to the city can be best appreciated when it is known that there are three dams across the Mississippi within the environs of the city, and that they have a total average horsepower of from 55,000 to 60,000. All of this power is in constant use in running the flour mills or to provide electric current to be used by the street railway. Another thirty foot dam across the Mississippi near Minnehaha Falls will soon be completed, but what use will be made of the 15,000 or 16,000 horse power from this dam has not yet been decided. Still another source of power is the St. Croix River at Taylor's Falls, fifty or sixty miles away. This has an ultimate capacity of 40,000 or more horsepower. At present the General Electric Company brings to Minneapolis from this source 20,000 or 25,000 horse power to be used for lighting and other purposes.

Industrial Development

With all these advantages, Minneapolis would have been slow to develop had it not been fortunate in having its development furthered by the indivi-

dual and organized effort of progressive men. And as men have responded to these natural conditions industry, commerce, education and beauty have come into being.

Flour. Of the manufactures, flour and other cereal products stand out preeminently; for, as is well known, Minneapolis is the largest flour manufacturing center in the world. The annual grain receipts are nearly 200,000,000 bushels. During the months of September, October, November, and December, 1915, more than a thousand carloads of grain were received daily, and of the total during these four months, nearly eighty thousand carloads were wheat. This vast quantity of grain is stored in fifty terminal elevators with a storage capacity of 38,550,000 bushels.

But this wheat has not long to lie in elevators, for at the rate of nearly 80,000 barrels a day the twenty-three mills grind it into flour, the annual output being about 18,000,000 barrels, having a value of about $70,000,000. This flour finds a ready market in all countries of the earth where men eat white bread. However, with the ever increasing demand in this country, only a little over a million barrels a year are exported.

Linseed Oil. Next to flour comes linseed oil, of which Minneapolis is the largest manufacturing center in the world. Flaxseed in large quantities is received from the grain fields of the northwest. During the year 1913 fourteen and a half million dollars worth of oil and six and one half million dollars worth of oil cake were manufactured. While the oil finds a ready domestic market, 75 per cent of the oil cake was exported.

Lumber. For many years Minneapolis has been considered the lumber center of the northwest. With the clearing away of the northern forests it is losing its importance as a lumber manufacturing center, though it still has an annual output of something like 200,000,000 board feet, and the output of lumber and lumber products have a value of $12,000,000. While the manufacture has decreased in recent years Minneapolis firms still own and finance thirteen hundred retail yards through which they distribute 1,500,000,000 feet of lumber. It not only leads all cities in the distribution of lumber but with its twenty-eight factories, leads in the manufacture of sash, doors, etc.

Farm Machinery. With abundant labor, capital and power at hand, and with thousands of farmers on the vast plains calling loudly for more and better machines, Minneapolis has recently become the leading city in the distribution of farm implements. Not only is it a distributing center, but also occupies an important place in the manufacture of gas tractors, threshers, plows, etc., as well as many other kinds of machinery on a smaller scale.

Other Manufactures.—Printing also occupies a place of some importance with over two hundred establishments, and a product valued at six and one half million dollars.

To these may be added such products as bread and bakery goods made in one hundred establishments and having a value of over three million dollars; butter, cheese, packed meats, confectionery, ice cream, malt liquors, drugs, medicines, and tobacco, with a total value of almost ten million dollars. Clothing, building materials, furniture, jewelry, leather goods, paper goods, etc., swell the total factory output to over $200,000,000.

Transportation

With nine railroad systems, consisting of twenty-six lines, entering the city, Minneapolis has facilities not only for collecting farm products, but is well equipped as a distributing center. The shipping facilities are made doubly effective by the fact that railroad lines extending eastward parallel the Great Lakes thus making the rates low. Added to this is the fact that within another year, with the completion of the thirty foot dam across the Mississippi near Minnehaha Falls, Minneapolis will become the head of navigation. Terminal facilities for handling river freight are nearing completion. A six foot channel is promised. Through the one thousand jobbing houses an annual wholesale business of $300,000,000 is transacted.

Public Improvements

The physical features within and around the city are such as invite improvement for the welfare and pleasure of the people. Within a radius of twenty-five miles there are two hundred lakes, including Harriet, Calhoun, and the far famed Minnetonka. With a total area of fifty-three square miles, Minneapolis has eighty-five parks containing about four thousand acres, one third of which is water. There are thirty-seven miles of park drives and boulevards connecting the public parks, including Minnehaha Falls. There are twenty-two miles of Mississippi River frontage, with eighteen bridges crossing the river. The city water plant consists of two reservoirs and five hundred twenty-one miles of watermains. There are two hundred miles of paved streets and three hundred fifty miles of sewers. The street railway has one hundred eighty-eight miles of track and operates five hundred twenty-five cars.

As an educational, music and art center, Minneapolis ranks high. In addition to 50,000 children attending seventy grade schools and six high schools, ten thousand children attend other schools within the city. It is also the seat of the State University with an enrollment of seven thousand three hundred.

Thus Minneapolis, "City of the Falls," in the midst of raw materials and with accessible markets and enterprising business men has become a city of beautiful homes built up with her ever growing industries and expanding commerce.

MINNESOTA CITIES: ST. PAUL

By L. L. Everly
St. Paul Normal School

SEATED on her seven hills, this capital city occupies a position that is both picturesque and full of historic interest. At the southwest corner of the city the bayou-strewn valley of the Minnesota joins the similar valley of the Mississippi which continues northwestward into the heart of the city and then turns abruptly southward. The steep right bank rises from one to two hundred feet above the river, while the left bank, rising half as high, takes the form of a stone terrace a half-mile or more in width and furnishes a commodious area for the business portion of the city. Back of this, morainic hills tower another hundred feet and offer a picturesque location for the residences and numerous parks. Thus, one may ascend from the alluvial flats at the river brink with their public baths, steamboat docks, railroad yards, and Union Station to the stone terrace with its great wholesale warehouses and business blocks, and then on up to the higher level with its residences, stately churches and imposing State Capitol.

First discovered by Father Hennepin in 1680, visited by Jonathan Carver, a Boston trader, in 1766, officially described by Lieut. Zebulon Pike in 1805, St. Paul began as a settlement and trading post in 1838. Down the Minnesota and Mississippi came the birchbark canoes laden with furs, while up the great river came the trader and settler. Eleven years later the settlement had grown to a population of 840, had been surveyed and organized as a town, and honored by being made the capital of the new territory.

In 1847 a line of river packets began making regular trips between St. Louis and St. Paul. From the Red River valley and the great plains of the Dacotas thousands of buffalo skins were brought by caravans of "Red River Carts," often a hundred in a single caravan. These strong, wide, wooden carts brought their loads so frequently that it was not an uncommon sight to see acres of bales of buffalo skins awaiting shipment on the levees.

In 1871 local manufacturers began making these skins into overcoats and sleigh robes and soon developed a wholesale trade. The buffalo became extinct in 1884 but since that time St. Paul has maintained her preeminence as the leading manufacturing center of *high grade* furs in the United States. Sixteen firms are now working up over 2,000,000 skins each year, the total business exceeding $7,000,000 annually.

From this head of river navigation railroads began developing in 1862 until now nine railway systems (23 lines), four being transcontinental lines, center here, representing a total mileage of over 57,500, about one-fourth of the total railway mileage of the United States. Seven railroad repair shops located here furnish an annual product valued at nearly $4,000,000. Three hundred and thirty-nine passenger trains and an average of 29,000 passengers pass through the St. Paul Union Station every day. Passing this station are the tracks of an interurban electric railway operating over 400 miles of track

while one block away are the docks of the river packet lines. River traffic is increasing with new types of all-steel barges and deepened channel.

The splendid railway service to the north and west has developed many industries. It brings shipments of a coarse grass from glacial swamps to yield its fiber for the manufacture of carpets, and also the product of the great wheat fields to supply the needs not only of a large modern flour mill but also those of one of the world's greatest bakeries turning out 100,000 loaves daily.

The shipments of the products of the grazing lands of the northwest have caused the growth of the live stock market and meat packing industry. From a small market supplying local needs it has grown to become a world's market, doing an annual business of over $500,000,000. Each day long strings of cars discharge hundreds of cattle, sheep and hogs, sufficient to make an unbroken line seven miles in length.

The leather from the hides of domestic animals is used in great quantities by the workmen of four shoe factories. From small beginnings they have developed until over 3,000,000 pairs are manufactured annually.

The butter from the $100,000,000 worth of milk yielded by Minnesota dairy cattle comes in such quantities to St. Paul as to make it the second largest butter-producing market in the nation. Ten factories strive to produce a uniform quality and flavor of high merit. Minnesota's abundant grasses, copious supply of pure water and numerous converging railway lines serve to accomplish this result.

From the pine forests comes the material which three factories make into boxes. Machinery planes the boards, saws them to proper length and drives the nails, thus turning out daily over 10,000 boxes to meet the needs of the wholesale houses and other shippers.

Another industry, but one step removed from this, is the use of carloads of paper, a by-product of the forest, in the manufacture of boxes. Several firms are busy at this work, turning out millions of boxes, cartons, and containers of every description.

Likewise another product of the forest paper and the efficient mail service of the many lines of railway is the great development of the printing and bookbinding industry. Over seventy firms are engaged in this industry, producing newspapers, magazines and books having an annual value of over $50,000,000.

The buffalo overcoat of former years has disappeared but in its place the sheep-lined coat and woolen mackinaw serve quite as effectively. The growing wholesale trade in these has called for a trade in other forms of men's furnishings. Over 5000 pairs of overalls are manufactured daily, while 1,000,000 hats and a still larger number of shirts are supplied to the trade annually.

Likewise one of the largest millinery establishments in the world to-

gether with a half dozen other wholesale millinery houses are located here turning out over a million hats annually.

A wholesale trade in drugs, chemicals, dental supplies, candies, mushrooms, brushes, and other commodities has grown to supply the local trade and that of the great northwest.

These various industries have developed the city as a financial center. Fifteen banks in operation, annually receive deposits of more than one hundred millions of dollars. Business activity has resulted in clearing house receipts of more than two million dollars daily.

The greatest public building of the city is the State Capitol imposingly situated on a commanding eminence. It is a marble building of beautiful proportions, richly decorated with famous paintings and sculptures. It was erected at a cost of $4,500,000. The Federal Building, United States Customs House, City Hall, and Court House, Wilder Charities Building and Public Baths, the fireproof Municipal Auditorium seating 10,000 people, and the new million dollar Public Library, are some of its chief public buildings. Beautiful churches and an imposing cathedral serve the people's higher interests.

Six colleges, four seminaries, four public high schools, a city normal school, fifty-seven public schools, an institute with its art school and evening classes in many departments, known as the Peoples University, together with twenty parochial schools, offer splendid educational advantages. The six colleges are the State Agricultural College, Hamline University, Macalaster College, St. Thomas College, Concordia College and the St. Paul College of Law.

The city's low typhoid death rate of 19.5 per 100,000 is due to pure city water obtained not from the river but from a series of spring-fed lakes extending twenty miles north of the city, to its hills with a sandy subsoil providing a perfect drainage, and to its bracing climate.

Nine public playgrounds maintained by the city, equipped with shelter houses, swimming pools, shower baths and out-of-door apparatus, invite to hours of pleasure.

With its picturesque river, with its numerous lakes within convenient trolley ride offering opportunities for motorboating, canoeing, fishing and camping, and with its seventy-nine parks and famous boulevards, St. Paul is indeed a city beautiful. The city's future is bright with promise.

MINNESOTA

NORMAL SCHOOLS

Minnesota supports five State Normal Schools: at Winona, Mankato, St. Cloud, Moorhead and Duluth. The aggregate attendance last year (1914) was 4,166. Tuition is free. The cost of board and room is from $3 to $3.50 a week. Dormitories are provided at all of the schools.

MINNESOTA CITIES: DULUTH AND THE RANGE TOWNS

By Eugene Van Cleef
State Normal School, Duluth

UNIQUE, is the word that best describes the group of cities in the northeastern corner of Minnesota. Nowhere on the surface of the earth can a situation similar to this one be cited. True, one may point to harbor cities and to couplets consisting of an inland town and its port on the sea. But where is there another Iron Range like that in Minnesota, beaded with cities of such remarkable growth and unusual contrasts? Where is there another harbor such as Duluth's, so spacious, so nearly ideal, yet whose business is so simple?

The Iron Ranges

About 85 miles north of Duluth lies the Mesabi Range and about 15 to 25 miles further north is the Vermilion Range. These ranges do not consist of a series of conspicuous heights of land, but rather constitute a rolling topography with occasional hills rising from 100 to 150 feet above the general level. The average height above sealevel is about 1500 feet and above Lake Superior about 900 feet. The Mesabi Range assumes an inverted S (*S*) form with the ends decidedly elongated. The general direction is east by northeast to west by southwest. At the western extremity the last town of size is *Hibbing,* while the eastern extremity is marked by *Biwabik.* Between these towns, going from west to east, one passes through *Chisholm, Buhl, Virginia* and *Eveleth.* Separating these towns are still smaller communities.

On the Vermilion Range, *Tower* marks approximately the western extremity and *Ely* the eastern end with no town of consequence between. This range, of more limited area than the Mesabi and of different structure, trends in a slightly northeast-southwest direction.

The entire northeastern portion of the state was covered with extensive white pine and giant Norway pine forests to within about 25 years ago. The pioneer with pack on his back penetrated the stillness of this wilderness. It was not long before he became aware of the presence of ore, although at first he did not realize the magnitude of the wealth which lay under his feet. Many a man turned back from the wild lands and the miseries of long cold winters; but a few continued exploring the region, eventually to be well repaid for the hardships endured. In 1884 small shipments of iron ore reached Two Harbors. In 1892 the output of the Vermilion Range equalled nearly one million tons, and that from the Mesabi only 29,000 tons. The quantities of ore shipped now from the Mesabi Range annually approximate 25,000,000 to 30,000,000 of tons.

The Range Towns.

The growth of the Range Towns may be characterized as of the mushroom type. *Hibbing* dates from 1892 and today has a population estimated at 12,000. The village of *Chisholm* only 7 miles east, was incorporated in

1901 with a population of but 250. In 1910 the U. S. Census reported 7684, and now the residents estimate the population close to 10,000. *Virginia* numbered only 2962 in 1900. The estimate for 1915 as given by the Federal Census Bureau is approximately 15,000. Such a growth occurred despite a devastating fire in 1903 which momentarily erased the town from the map.

The structure of these *villages,* as they are technically designated, is rather striking. In most instances the great open-pit mines form a circle about the village. The miners do not live in the center of the village, but rather in rows of frame houses of uniform architecture, which occupy the vacant areas between the mines. These *Locations* as they are termed, lie from a half mile to four miles from the business district. The Locations are moved by the mining companies as the mines encroach upon them. In fact whole towns of several thousand people have been unhesitatingly transported a distance of a half mile to a mile in order that mining operations might be extended. Occasionally a Location grows to such size and importance that it is incorporated within the village limits, thereby adding materially to the wealth of the community, for the larger the area of ore deposits within the village, the larger the amount of taxes that go into the village treasury. There may be as many as six to ten Locations about a village.

Industries Other Than Mining

In only one of these towns has the lumber industry exercised a decided influence. A large white pine lumber mill, said to be the largest of its kind in the country, has contributed a good share to the prosperity of Virginia. Lumber mills have been located at other points on the range, but for only relatively short periods of time. No other industries of significance have been established.

At present the inhabitants are giving much thought to agriculture. In fact one may well say that there exists an "agricultural boom." It is estimated by some that the iron resources will last a hundred years or more. But there are those who realize the importance of a permanent resource and hence seek to establish one. The timber of value has been cleared, and now the land awaits the further enterprise of man. Earnest attempts have been made to produce crops, and some have attained a little success. Hay and a few root crops grow well, but the climate is still a handicap to general agriculture, especially to that which involves the raising of foodstuffs for the people. With eventual acclimatization of crops, such fertile soils as cover this territory may be expected to yield in goodly quantities. Patience and honest exploitation must result in final success. These communities may then become independent of iron mining, instead of continuing their present parasitic life.

The Mixed Population

The population is decidedly mixed. A few figures to show the nationalities of the students in the schools of Hibbing for 1913-14 will serve to represent the entire Range, for the mixture everywhere includes about the same

types and in the same proportion. Among 2355 students only 439 were Americans, that is, those whose parents were born in America.* The Finns rank next with 409, the Swedes with 321, the Italians with 315, and the Austrians with 210. The remaining 661 were divided among 24 nationalities. Such a motley assemblage, carrying with it the opinions and prejudices of 29 different nations, presents a problem in city government not easy of solution. Education has been the first attempt at solving the question of amalgamation. With the tremendous resources and the excellent foresight of the mining companies, school equipment has been provided which is not equalled anywhere else in the country. The brief period since the founding of these towns has not given a sufficiently long experience in the education of this mixture to afford conclusive results.

The future of the Range towns depends upon the extent of the deposits of iron ore still unmined and the rate at which the nations will continue to consume the ore. However, no matter how long the supply may last, the region must be developed agriculturally, or these towns will sound their knell with the last carload of ore.

Duluth

At the front door of the Iron Range, Duluth has risen. It lies at the western extremity of the world's largest inland fresh water lake and at the farthest point inland along the Great Lakes' highway. It therefor is in easy and cheap communication with eastern cities and European ports.

In addition to iron ore, grain and lumber play a significant role in the development of the hinterland. In more recent years the cut-over lands and the muskeg (swamp) lands have begun to yield produce in diminutive amounts. While it is very doubtful whether sufficient quantities will be raised for large shipment, locally it may prove an important resource.

The city has grown steadily from about 5000 in 1880 to 78,466 in 1910. It may have reached 85,000 in 1915. The continued rise has in no small degree been due to the facilities for shipping to the east. The area of the harbor now accessible to railroads (as wharfage) is 664 acres while the total available area is 4069 acres. The entire harbor space includes eleven square miles, or 7040 acres. Neither Liverpool, Rotterdam nor Hamburg approach this area. Furthermore the linear quayage is roundly 49 miles, second only to that of New York City. The harbor is well protected from storm waves, tides, or strong currents; it is deep and has a soft bottom making anchorage easy. Boats 600 feet long and drawing from 20 to 26 feet of water maneuver easily without the aid of tugs.

Such facilities invite *commerce*. The tonnage for the eight months' season of navigation is next to that of New York City. The value is not so great for the commodities are raw materials of large bulk. Duluth distributes not alone to the east but also to the west. In exchange for lumber, ore, and grain, it receives tremendous supplies of coal, some hardware and grocer-

*The authority for these data states that a few may possibly have mothers of foreign birth.

ies. Clothing comes very largely by rail. These products are distributed throughout the northwest where they are in demand.

Manufacturing is limited to clothing, lumber, logging machinery, a little flour, bread, matches, and such other items as may find a ready sale in the northwest or locally. A plant for the manufacture of steel has been in the process of construction for many years. It is proposed to begin operations this year. Probably the distance from the eastern markets, high cost of labor locally, cost of transporting coal and limestone both of which must be brought from a distance, have been factors in delaying the beginning of this industry.

As long as iron ore and grain are available Duluth will continue to thrive. Lumber is less a factor now than years ago, for the forests are fast disappearing and each year sees the shutting down of some mill in the vicinity. The permanence of the city, as in the case of the Range Towns, lies not in the iron resources, but in the development of the agricultural resources. A certain food supply at low cost must be made available. When the latter is assured, the city will be a welcome haven to the masses, and industries of many varieties may develop without limit.

MINNESOTA

THE LESSER CITIES OF MINNESOTA

By R. J. Scarborough
State Normal School, Winona

WINONA, "The Gate City," ranks fourth among Minnesota cities, having a population of 22,000. It is situated in the Mississippi valley 103 miles below Saint Paul, 50 miles above the south-east corner of Minnesota, and 310 miles from Chicago.

The physical features of the vicinity include the river flood plain with its terraces, bordered by high bluffs. The river flows nearly eastward here, is about one-half mile wide, and the distance across the valley is three miles. The bluffs rise about 450 feet above the valley. Lying between the city and the southern bluffs, Lake Winona occupies a basin made by a former channel of the river. The city occupies the higher ground between the lake and the river, an area about one mile wide and four miles long. The streets, platted parallel to the river, and at right angles, extend about 20 degrees east of northward. In the extreme east the streets extend more nearly westward and northward. Valleys which have incised the upland make natural grades in which roads have been constructed leading to the city.

Transportation is made convenient for Winona by the roads of five railway companies and by transportation on the river. This last named means may increase greatly in importance within the next half-century, linking the name of Winona with those of Dubuque, St. Louis, Memphis, and New Orleans.

Three steel bridges span the Mississippi at Winona, there being two railway draw-bridges and a high wagon-bridge. Improved roads reach for ten

miles east, south, and west. Trolley cars are in service through nearly the entire length and width of the city.

Winona is an important manufacturing center, though the saw-mill days are gone. It is noted for proprietary medicines, stock-foods, flour, confections, wagons, linofelt, etc., sold over the United States and Canada. One medical company, having an imposing half-million dollar plant in Winona, in which nearly 400 people are employed, has 2700 salesmen working in 48 states and six provinces. The North Western Railway Company's shops employ 275 men. Cheap electric power is brought from Hatfield, Wisconsin, 60 miles east on the Black River, and a new plan proposes to generate additional power at Chippewa Falls, 100 miles northeast.

Parks are seen on the river-front, in the midst of the city, on the Lakeshore, and on the bluffside at the southwest. A fine new high school building is nearing completion. The Winona State Normal School, Minnesota's oldest and best equipped Normal, is justly proud of a new and complete Model School building, a Library building, a Dormitory occupying an additional city square, and a Model Rural School located four miles southwest of the city. The College of St. Teresa, for young women, and St. Mary's College, for young men, rank with the colleges of the northwest. Winona has two daily newspapers.

Red Wing (12,200) of Goodhue, is picturesquely situated on the bluffs overlooking the Mississippi, which is here spanned by a high bridge. Fourteen hundred people are employed in thirty manufacturing establishments. Furniture, linseed oil, sewer-pipe, and stoneware are among the principal products. Located at Red Wing are the Lutheran Ladies Seminary, the Red Wing Seminary for young men, and the State Training School.

Stillwater (11,000) overlooking Lake St. Croix, lies twenty miles northeast of St. Paul with which it is connected by trolley. Abundant water power has developed considerable manufacturing. The new State Penitentiary is located at Oak Park, a suburb of Stillwater, and in that institution a great amount of binding twine and machinery are manufactured.

Mankato (12,000) at the southernmost turn of the Minnesota River, is the metropolis of south central Minnesota. Four railway companies and the "Dan Patch" interurban serve the city. Street cars are also in service. Mankato is noted for its stone, lime, and cement, having a cement works with an annual capacity of 225,000 barrels. About fifty distinct industries are represented. A power plant on the Blue Earth River supplies cheap and abundant power. Two daily papers are published. Minnesota's second oldest State Normal School, and the Lutheran Ladies Seminary are located here.

Rochester (9,000) is noted nationally as the city of a good hospital and Drs. Mayo and Mayo. Usually about 1,000 persons are present in the city for treatment at St. Mary's Hospital. One of Minnesota's hospitals for the insane is here. The naturally pleasing site on the Zumbro River has been improved by a fine park system and extensive paving. The Franciscan Sisters'

Academy is located here. A large flour mill and a camera factory are two of the principal manufactories. Two daily papers are issued.

Faribault (10,000) is located at the confluence of the Straight and Cannon rivers. The business center stands on ground between the streams, while stately institutions and schools occupy the hills to the eastward. Topography and culture have given Faribault locally the name "The Athens of the Northwest." Here are located Shattuck Military School, Seabury Divinity School, Bethlehem Academy, and the State Schools for the Deaf, Blind, and Feeble Minded. Forty-three manufacturing establishments in Faribault are enumerated by the U. S. Census of 1910.

Albert Lea (8,000) of Freeborn, the "railroad spider" on the map of southeastern Minnesota, is built on high ground between two lakes. It is a jobbing and manufacturing point, and, excepting Duluth, has the only coal elevator and screenery plant in Minnesota. In the county, dairying has superceded wheat, and the city has a State Demonstration Creamery.

St. Cloud (11,000) "the Granite City," is the county seat and commercial center of Stearns, noted for granite quarries and fine stock. Three hydro-electric plants on the Mississippi furnish abundant power. Electric cars run throughout the city and on suburban lines north and west. The industrial establishments include two large flour mills, iron foundries, machine shops, and a woolen mill. Eight hundred men of the Great Northern shops, and of the train service, have their homes in St. Cloud. Two daily papers are published. Overlooking the river stands the St. Cloud State Normal school which has the largest enrollment of the state's five normals. St. John's University (Theological) and St. Benedict's Academy for girls are located near.

Little Falls (9,000) is a center for the manufacture of lumber, flour, paper, and creamery products.

Brainerd (10,000) the "Hub City," is located exactly at the geographical center of Minnesota, and has railway connections in the four directions. The Northern Pacific repair shops, located here, employ over 1,200 men. The Cuyuna iron deposits extend within the city limits.

Crookston (9,300) located at the edge of the Red River Valley has railway lines in eight directions. Electric power is developed from Red Lake River, and typical industries are flour mills, a saw mill, and a brick yard.

Fergus Falls (7,500) built on both sides of the Red River of the North has some of the finest hydro-electric developments in the northwest. Five dams furnish power to four flour mills, to the municipal electric-light plant and water works, and to nine other factories. Fergus Falls has the largest milling capacity between the Twin Cities and the Pacific coast. The State Hospital for the Insane has 1,400 patients and 300 employees.

Moorhead (5,500) is on the Red River opposite Fargo. Moorhead has railway lines in eight directions, also an efficient electric railway service throughout the city and to Fargo. The city's manufactories include a flour

mill, two wagon factories, a plow factory, and a planing mill, while just east of the city the Northern Pacific shops are located. Minnesota's fourth Normal School is located here. Concordia College stands in the south part of the city.

International Falls (4,500) of Koochiching, stands at the national boundary, separated from Ft. Francis, Ontario, by the Rainy River. Using electric power from the Rainy River, a pulp and paper mill, a saw mill, and a planing mill, are among the leading industries. An electric interurban connects with Ranier, five miles east. A daily paper is published.

Cloquet (8,000) located on the St. Louis River 25 miles from Duluth has five large saw mills and a fine paper mill. The manufacturing plants employ 2500 men. Logs often jam the river for miles. The city has a picturesque setting in the deep valley and on the hill sides.

———*MINNESOTA*———

THE STATUS OF GEOGRAPHY IN THE PUBLIC SCHOOLS

By P. C. Tonning
State Department of Education, St. Paul

In the Elementary Schools

GEOGRAPHY is more generally studied in the public schools than any other subject except possibly English and arithmetic. As a formal subject it is usually introduced in the third or fourth grades. The first work consists in the study of home geography, the village or the community, and the county, including the study of occupations, products, and industries, surface features from field excursions, streams, lakes, waterways, and so forth.

Sometimes the work is based on some such book as Robinson Crusoe; the struggle of man with the elements, and the manner in which he makes use of the natural resources at hand being the prominent geographical features of such study.

An elementary text book is introduced, as a rule, in the fourth or in the fifth grade. The work is frequently supplemented by the use of geographic or industrial readers. The advanced textbook is usually taken up in the sixth grade and completed in the seventh, leaving the geighth grade without work in geography. In some schools textbooks are practically dispensed with, supplementary geographic readers, periodicals, and reference books taking the place of the text.

In the High School

In the high school the subject is taken up in the form of physical geography, commercial geography, and what is known in Minnesota as senior geography, which is simply a review and amplification of a part of the grammar school geography. Each one of these subjects is studied for one semester and carries one-half credit towards graduation. The reports of the high and graded school inspectors show that last year physiography was studied in one

hundred and fifty-six high and graded schools; commercial geography in eighty-four; and senior geography in forty-two. It must be said, then, that on the whole, geography is a popular branch of study in the public schools. But the development and general results have not been commensurate with the importance of the subject—the only true sociological subject in the curriculum.

Principal Defects in Geography Teaching

One of the greatest defects in the work in geography is the purely statistical and cyclopedic character of the instruction in the upper grades. A teacher may start out with the correct basic notions and principles of geography with the study of man in relation to his environment, but textbooks and examination questions soon deflect him into the easy and well-beaten paths that result in mere memoriter work.

It is also a grave mistake to drop the work in geography in the seventh grade. This is quite a common practice in the schools of the state, and the result is that the study of geography is discontinued just at a time when the reasoning faculties of the pupils are developing, and at a time when the student could get the most value as well as enjoyment out of the work. The study of geography should be continued throughout the eighth grade. This is especially necessary when we consider that a large percentage of the pupils that go through the grades never pass into the high school, to continue geographical studies. For such pupils, as well as for others, geography is one of the most practical studies of the elemenetary curriculum, and the benefits resulting from its study should not be curtailed by discontinuing it at the end of the seventh year.

A few high schools organized on the junior-senior plan have introduced in the eighth year a practical course in elementary commercial and industrial geography. The work begins with the study of the geographic conditions bearing upon the commercial and industrial life of the community and of the state. From the community and state as a center, the work is extended to include the United States and foreign countries.

Physical geography or physiography as studied in the high school has developed into what might be termed an unrelated science, and is in much the same position that chemistry was in a few years back. It does not seem to lead anywhere or to have any practical bearing upon life or man's relation to the soil or climatic conditions. It has come to be largely a study of elementary geology.

Physiography can be made a very valuable high school subject, but its value in the high school curriculum will depend upon the extent to which it is related to the life and activities of the human race. Physical geography as now commonly taught, and senior geography, might well be dropped from the curriculum of the average high school, and the time given to a strong course in commercial and industrial geography, with enough of the physical geography to serve as a background for a proper understanding of the geographic facts bearing upon industrial and commercial life.

The above figure is from a photograph of a model about 3¼ feet square recently made for the University of Minnesota. It is based upon 4 quadrangles of the U. S. Geological Survey, 1 inch to the mile. The remarkably pitted surface with its many lakes is due to morainic deposits. The width of the valley of the Minnesota River (botton of map) at once suggests that it was once the channel of a much larger river; this larger river drained Glacial Lake Agassiz.*

*The model is made and sold by E. H. J. Lorenz, Madison, Wis., from whom price and desired information may be obtained.

MINNESOTA

The total daily capacity of the 303 mills in Minnesota is given as 165,715 barrels of flour, of which 84,600 barrels is from 23 mills located at Minneapolis and 5,900 barrels from 4 mills at Duluth. In addition to the Minnesota output there is a demand for 15,200,000 bushels of wheat from the North and South Dakota mills. Thus there is a local demand for 142,784,552 bushels of wheat in this immediate Northwest.

STATISTICS SHOWING THE GROWTH OF MINNESOTA

	1850	1860	1870	1880	1890	1900	1910
Population	6,077	172,123	439,706	780,773	1,301,826	1,751,394	2,075,708
Population of St. Paul	2,227*	12,150*	23,085*	41,473	133,156	163,065	214,744
Population of Minneapolis	750	12,849*	31,566*	46,887	164,738	202,718	301,408
Population of Duluth		406*	4,561*	3,483	33,115	52,969	78,466
Acres improved farm lands	5,035	556,250	2,322,102	7,746,693	11,127,953	18,442,585	19,643,533
Acres unimproved farm lands	23,846	2,155,718	4,161,726	6,156,326	7,535,692	7,805,913	8,032,290
Total value farm products in $			33,446,000	49,468,000	71,238,000	112,420,000	185,832,000
Bushels of wheat	1,401	2,186,000	18,866,000	34,601,000	52,300,000	95,278,000	57,094,000
Bushels of corn	16,725	2,941,000	4,743,000	14,831,000	24,696,000	47,256,000	67,897,000
Bushels of oats	30,582	2,176,000	10,678,000	23,382,000	49,958,000	74,054,000	93,897,000
Bushels of potatoes	21,145	2,565,000	1,943,000	5,184,000	11,150,000	14,643,000	26,802,000
Tons of hay harvested	2,019	179,000	695,000	1,637,000	3,135,000	4,339,000	6,036,000
Pounds of butter	1,100	2,957,000	9,522,000	19,161,000	34,766,000	41,188,000	34,708,000
Value of all live stock in $	92,000	3,642,000	20,118,000	31,904,000	57,725,000	89,063,000	161,641,000
Value of slaughtered animals in $	2,840	751,000	3,076,000	887,000	2,544,000	7,810,000	25,753,000
Total annual value of manufactured products in $	58,300	3,373,000	23,110,000	76,065,000	192,033,000	223,692,000	409,420,000
Cost of material used in manufacturing in $	24,300	1,904,000	13,842,000	55,660,000	118,481,000	173,425,000	281,622,000
Value of flour and grist mill products in $	500	1,310,000	7,534,000	41,519,000	60,158,000	82,988,000	139,136,000
Value of forest products in $	57,800	816,000	4,538,000	9,368,000	30,018,000	42,689,000	42,352,000
Production of iron ore (long tons)	0	0	0	'84- 62,124	891,000	9,834,000	31,966,000
Miles of railroad	0	0	1,092.50	3,099.32	5,409.11	6,794.68	8,483.56
Percentage of iron ore produced of total for the United States				(1884) 1.5	8.47	43.3	56.19

*Includes the population of the whole county in which the city is located.

THE DEATH OF EDWARD VAN DYKE ROBINSON

AGAIN we are called upon to report the death of a valued member of our editorial staff:—Professor Edward Van Dyke Robinson who had within a few months accepted a chair of Economics at Columbia University. By a strange coincidence this report of Professor Robinson's death finds its place in an edition of this magazine devoted to the State in which he did his most mature educational work, Minnesota. Although he had been called to Columbia a few months before his death in December, his connection with the University of Minnesota extended back to 1907. Still earlier he was a principal of one of St. Paul's high schools. He was the author of a number of works, chiefly in the field of Economics, but including also a widely used high school Commercial Geography. He was a member of the Association of American Geographers and for nearly ten years was an associate or contributing editor of this magazine. Especially sad is the death of a man in the very prime of his intellectual life (49 years), finely equipped for a scholarly career, and just entering upon a promising new field of work in one of America's old and distinguished universities.

THE WEALTH OF MINNESOTA

Note—The following pages are excerpts from a paper by the late Professor E. V. Robinson, read before the Second Annual Meeting of the Minnesota Academy of Social Sciences at Minneapolis, Dec. 3-4, 1908; *the entire paper is printed in the annual Proceedings of the Academy.—Editor.*

THE first white men in Minnesota were Frenchmen, who came by way of the Great Lakes, (1659); and their motive was the fur-trade. Ten years before the Declaration of American Independence, there was a considerable settlement at Grand Portage, 146 miles from Duluth, where the canoe route from Montreal left Lake Superior for the Rainy River, Lake Winnipeg, and Great Slave Lake. Another early center of the fur-trade was at La Point, on Madeleine Island, near Ashland, Wis., which was for many years (after 1816) the seat of the Astor interests in the Northwest, and had intimate relations with Minnesota by way of the St. Croix River. The first settlers on the upper Mississippi were also connected with the fur-trade. In this class belong not a few men prominent in early Minnesota, notably N. W. Kittson, Henry M. Rice, Charles W. Borup, William and Allan Morrison, and H. H. Sibley. And the importance of the fur-trade was further enhanced when the Red River carts established connection (1843) between the Hudson Bay Company's factory at Winnipeg and St. Paul. These facts of history, taken in conjunction with the large areas of sparsely settled woodlands in

Minnesota, serve to explain why St. Paul is still the greatest primary fur market in the United States, and one of the greatest centers of fur manufacture.

The second economic motive which brought men to Minnesota was the lumber industry. Most of the early lumbermen were recruited from the lumber districts of Maine, and they transferred to Minnesota the lumbering methods which had been developed in northern New England. The first logs were cut for market on the St. Croix in the winter of 1836-37; and just ten years later, lumbering began on the Rum River, a tributary of the upper Mississippi. Mills were soon built at the falls of these rivers, and immense quantities of logs were also rafted down the river as far as St. Louis. At Moline, Rock Island and other river towns, mills were built especially to saw logs from the St. Croix. The lumber industry in fact brought to Minnesota most of the people, aside from those connected with the fur-trade, who were here in territorial days. Minnesota lumber not only built up many towns on the Mississippi and its tributaries, but by reason of its cheapness and accessibility, it was a powerful factor in the rapid settlement and development of the prairie regions to the south and west.

Agriculture began late and under unfavorable auspices in Minnesota. There were, it is true, some farms here even in territorial days; but they were subsidiary to the lumber camps, and did not even meet the local demand, so that food had to be imported. Horace Greeley of the New York Tribune, who did much to prejudice people against this northern country, alleged in justification that it "imported loafers, the food they ate and the whiskey they drank." Moreover, until the Treaty of Traverse des Sioux in 1851, settlement was practically confined to the timbered region between the St. Croix and the Mississippi, the prairie section being still held and jealously guarded by the Sioux. This section was indeed first made known, even to people already settled in the territory, by a series of steamboat excursions up the Minnesota River in 1850. Mr. J. J. Hill has recorded that even so late as 1856, when he first came to Minnesota, the territory was considered good only for lumber, cranberries and fur. The first wheat to reach outside markets, according to Mr. Hill, was shipped down the Mississippi in 1857, the year before Minnesota became a state; and the first flour, also, according to Mr. Hill, was shipped from Minneapolis in 1862, being branded "Muskingum Mills, Troy, Ohio," in order to command better prices. The leading primary wheat market was at first Rochester, later Red Wing, and then Minneapolis. The great Red River district, which received its first agricultural settlers away back in 1811 (the Selkirk settlement from Canada) did not become a factor in wheat production until after 1870, when it secured railroad connection with Duluth.

Within the space of a dozen years, the pioneer type of agriculture which prevailed in Minnesota as elsewhere on the frontier, and whose purpose it was to produce everything possible upon the place, gave way to specialized wheat farming for the market. This sudden development on so gigantic a

scale as to render Minnesota one of the principal granaries of the world, was due to three causes, two of them common to other parts of the West, and one peculiar to Minnesota, or rather to the spring-wheat district of the Northwest. These causes were: first, the introduction of labor-saving machinery for reaping and threshing small grains; second, the coming of the railway; and third, the new milling processes.

The reaper was invented in the Shenandoah Valley as early as 1834. The threshing machine was invented as far back as 1840; but it remained of slight effect until the reaper had revolutionized methods of harvesting small grains. These and other improved kinds of machinery, coming into general use at the time when the prairie region of Minnesota was being settled, greatly increased the profits of wheat growing; and this not alone because they reduced the labor cost to a fifth or less, but also and chiefly because they made possible the harvesting of a large crop in a few days, which would otherwise have required many men and many days, and more serious still, would have been exposed to loss from storms before it could be gotten under cover.

The first transportation routes in Minnesota as elsewhere in the middle west, were the rivers—"the roads that run." The first steamboat on the upper river, the Virginia, came up to Fort Snelling, with a government cargo, in 1823. Steam navigation began on the St. Croix in 1838; on the Minnesota in 1850 (to Mankato), continuing until 1872, when the decreasing depth of water and the increasing competition of rail transportation rendered it unprofitable; and on the Red River in 1858. The same year marked perhaps the climax of steamboating on the Mississippi, there being 1,090 arrivals of steamers at St. Paul that season. In those days, La Crosse and Prairie du Chien were the ports of Minnesota for goods going overland to Milwaukee;* Galena was the port for Chicago until the railway from Chicago reached Rock Island (1854); and St. Louis was the principal base of supply and market for Minnesota products.

The first railway in Minnesota was opened in 1862, between the usual head of navigation at St. Paul and St. Anthony, now East Minneapolis. This was the beginning of the Great Northern system. The Minnesota Valley railway, now the Omaha, was also begun in 1865. But progress in railroad building was slow until the "boom" years preceding the panic of 1873. Then railway connection was established between the Mississippi at St. Paul and Lake Superior, at Duluth, in 1870; between Duluth and the Red River at Moorhead, also in 1870; between St. Paul and Chicago in 1871; between St. Paul and the Missouri River at Sioux City, in 1872; and finally, after the panic, between Minneapolis and the Red River Valley at Crookston and St. Vincent, by 1875. Thus in the brief space of five years, the exlusive dependence of Minnesota on steamboats and Red River carts abruptly ceased,

*In 1859, the exports of Minnesota via La Crosse and Prairie du Chein were 403 bales of buffalo robes, 100 bales furs, 343 bu. cranberries, 70,218 lbs. ginseng and 114 bbl. flour. (Flour manufacture in Minn., Minn. Hist. Collections, Vol. X, Pt. 1).

and the great routes of commerce by rail were established, much as they still exist today. In a commercial sense, by 1875 Minnesota had arrived.

At the same time occurred a revolution, or rather two of them, in the milling industry. Hitherto the plan had been to set the millstones close together and run them at high speed, thus reducing the grain to flour at one grinding. The pressure was so great as to cause the flour to heat and discolor; and the woody substance in the bran, being imperfectly removed, readily absorbed moisture and affected the keeping qualities of the flour. Both of these difficulties, moreover, were especially pronounced in the case of spring wheat —the only kind that could be grown in Minnesota. But in 1870 Edmund N. La Croix of Faribault came to Minneapolis and introduced the "middlings purifier," a French invention, into "Washburn B" mill; and in 1874 the Hungarian plan of using iron or porcelain rollers in place of mill-stones, was introduced into the "Washburn A" mill. The essential principle of the new process was multiple grinding with reduced speed and pressure, the wheat berry being at first merely cracked and the bran removed, and then reduced to flour by successive millings. In this way, the heating and discoloration were avoided, the bran was completely removed, and most important of all, the gluten, lying just beneath the bran and constituting the strength of the flour, was more largely saved. The effect was immediate and striking. Minneapolis flour began to command from $1 to $3 more per barrel than previously, and Minnesota spring wheat, which had been at a discount, went to a premium in the markets. The rise in price was from 10 cents to 40 cents per bushel, averaging perhaps 20 per cent of the previous selling price. This advance in the price of spring wheat rendered farming in Minnesota for the first time a profitable business, and caused an immense rush of immigration within the next few years. It established, in fact, the commercial prosperity of the spring wheat district of the Northwest. And as a result, it rendered spring wheat the principal—and for years almost the sole—commercial product of Minnesota agriculture.

Any reservoir, however, will run dry in time if it is continually drained and never replenished; and by the early '80's the yield of wheat had so far declined in the southern counties, owing to exhaustion of the soil, that more diversified farming became necessary, if general bankruptcy was to be avoided. The first plan was to rotate early ripening varieties of corn, which would mature, in Minnesota, with wheat. But while an inter-tilled crop such as corn increases the yield of wheat for a year or two following it, owing to the destruction of weeds and the aeration of the soil, it also hastens the decay of humus in the soil and the consequent loss of nitrogen. The last condition of the land is thus worse than the first. To restore nitrogen, either commercial fertilizers must be used, which will hardly pay for a crop yielding as small returns per acre as wheat; or else some legume such as clover, which can secure nitrogen from the air, must be inserted in the crop rotation; or, finally, large quantities of organic fertilizers must be applied. Either of the two latter

plans calls for the keeping of considerable live stock. About 1884, therefore, the dairy industry began to appear in southern Minnesota, doubtless in imitation of Iowa and Wisconsin, which had previously passed through the same crisis and found their economic salvation in the dairy herd. In subsequent years the dairy industry has spread toward the north, where the great ice sheet left large areas of sandy and stony land better suited to grass and root crops than to grain. And in the district between the Mississippi and St. Croix rivers, north of the Twin Cities, wheat farming has been largely abandoned in favor of potatoes, this district forming the famous Minnesota potato belt. Only the Red River Valley still depends almost exclusively on wheat as a market crop.

———MINNESOTA———

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———MINNESOTA———

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